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EFFECT OF FOLIAR SPRAY WITH SOME STIMULANT MATERIALS ON GROWTH AND NITROGENASE ACTIVITY OF PEA PLANTS

Manal A. Mandour[(1)], A. A. Ragab[(1)] and Omaima O. Mohamed[(2)]

[(1)] Central Lab. for organic agriculture – Agriculture Research Center

[(2)] Post harvest and handling of vegetables crops Dept. Hort. Res. Inst., ARC

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ABSTRACT: *Two field experiments were carried out during winter seasons of 2011/2012 and 2012/2013 at the Agriculture Research Farm, El-Kassasien Hort. Res. Station, Ismalia Governorate, Egypt, to study the effect of foliar spray with some stimulant materials active dry yeast (ADY), seaweed extract (SWE), humic acid (HA) and their mixtures on growth, dry weight, root system parameters as well as, nitrogenase activity and photosynthetic pigments, of pea plants (Pisum sativum L.) c.v Master B grown under sandy soil conditions using drip irrigation system.*

Spraying pea plants with active dry yeast at 5or 10g /l, seaweed extract and humic acid at 0.1or 0.2% as well as the mixture among them had a stimulative effect on vegetative growth, dry weight, root system, nitrogenase activity and photosynthetic pigments, as compared to untreated plants. Significant increase in the vegetative growth, dry weight of leaves and branches/plant, root system traits, nitrogenase activity and Photosynthetic Pigments were recorded by foliar application of the mixture of active dry yeast at 10 g/l + seaweed extract at 0.2% + humic acid at 0.2% followed by the mixture of active dry yeast at 5 g/l + seaweed extract at 0.1% + humic acid at 0.1%.

Key words: *Pea (Pisum stivum), active dry yeast, seaweed extract, humic acid, vegetative growth and photosynthetic pigments.*

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important and popular leguminous vegetable crops, which could be grown in wide types of the Egyptian soils especially in the newly reclaimed soils. It is important for soil fertaitily productivity of such crop is known to be poor in sandy soil mainly due to the scar city of macro-and micro nutrients, soil organic matter and absence of the root nodule bacteria (rhizobia). Inculated with the specific rhizobia for each legume crop and addition the recommended organic fertilizer in order to increase the efficiency of biological nitrogen fixation, and consequently improve the legume productivity.

Yeast are considered as a natural source of Bs vitamins and most of the essential elements (Nagodawithana, 1991). In addition, yeast extract is the natural component that contains many of the nutrient elements and cytokininis, which is safe and non-pollutant. It has a considerable amount of amino acids (Abou Zaid., 1984).

The effect of foliar application with active dry yeast on the physiological processes inside plants were studied by many investigators. El-Desuki and El-Gereadly (2006) on pea indicated that the vegetative growth of pea, and leaves content of photosynthetic pigments, were improved by spraying pea plants with yeast extract as compared with control. Mohamed, (2005) also found that active dry yeast as foliar application had a beneficial effect on growth and nitrogenase activity of comman bean plants especially at the highest rate (1.5g/l). Spraying pea plants with active dry Baker's yeast led to a significant increase in plant growth, content of total chlorophyll (Abdel-Aziz and Zakher 2010)

Also, it was reported its stimulatory effect on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Wanas, 2002 and Nour and Eisa,

2009). Improving vegetative growth of vegetable crops by application of yeast were recorded by Boby *et al.,* (2007) on cowpea; Nour and Eisa, (2009) on snap bean and Ahmed and Gheeth, (2013) on cowpea.

Seaweeds are the macroscopic marine algae found attached to the bottom in relatively shallow costal waters. They grow in the intertidal, shallow and deep sea areas up to 180 meter depth and also in estuaries and backwaters on the solid substrate such as rocks, dead corals and pebbles. Seaweed zone is one of the conspicuous and wide-spread biotope in the shallow marine environment. The seaweeds are totally different from higher plants as they neither have true leaves, stems and roots or vascular system none specialized sex organs (Thirumaran *et al.,* 2009). More than 15 million metric tons of seaweed products are used annually as nutrient supplements and biostmulants in agriculture and horticultural crop production (FAO 2006).

Many investigators studied the effect of seaweed extract as foliar application on plant growth, Temple and Bomke (1989) showed that seaweed application caused an increment in fresh and dry weight of leaves in beans of potato. El – Aidy et *al.,* (2002) reported that foliar application of seaweed extract significantly increased plant height, leaves number, leaf area, dry weight of leaves/plant of sweet pepper. Awad *et al.,* (2006) indicated that foliar application of seaweed extract at dose (2g/L) significantly increased plant height, foliage dry weight.

Spraying tomato hybrids with seaweed extract at a rate of 1 g/l recorded that best values of plant growth characters, leaves and total dry weight Nour *et al.,* (2010).

Nowadays the use of humic acid has increased with increasing the agricultural production and the most economical humic acid is almost applied directly to the soil and/or as a foliar application to the plants. Bio-organic fertilizer has been reported to be important in reducing the amount of chemical fertilizers application and hence reducing the environmental pollution along with reducing the production cost (Gad El-Hak *et al*. 2012).

Spraying plants with humic acid improved plant growth and productivity (Senesi and Loffredo, 1994; Khan *et al,.* 2012; Gad El-Hak *et al*. 2012; and Dawa *et al*. 2013; Ahmed 2013; on pea, El-Bassiony *et al*. 2012; and Hanafy *et al.* 2010; on snap bean, El-Hefny 2010; Azarpour *et al*., 2011) on cowpea.

MATERIALS AND METHODS

Two field experiments were carried out during winter seasons of 2011/2012 and 2012/2013 at the Agriculture Research Farm, El-Kassasien Hort. Res. Station, Ismalia Governorate, Egypt. It aims to study the effect of foliar spray with some stimulant materials (active dry yeast, seaweed extract, humic acid and their mixtures) on growth, dry weight, root system trait, nitrogenase activity and photosynthetic pigments, of pea plants (*Pisum sativum* L.) c.v Master B grown under sandy soil conditions using drip irrigation system.

The physical and chemical properties of the experimental soil field are presented in (Table 1) according to Chapman and Pratt (1982).

This experiment included nine treatments as follow:

Active dry yeast (ADY) at 5g/l and 10g/l, seaweed extract (SWE) at 0.1% and 0.2%, humic acid (HA) at 0.1% and 0.2%, (active dry yeast at5g/l + seaweed extract at 0.1% + humic acid at 0.1%) and (active dry yeast at10g/l + seaweed extract at 0.2% + humic acid at 0.2%) as well as control sprayed with tap water.These treatments were distributed in a randomized complete block design with three replications.

Seeds of pea cv. Master B were obtained from Horticultural Research Institute, Agriculture Research Center, Egypt. Seeds were sown on November 1th and 3th in 2011/2012and 2012/2013, respectively after inculcation with root nodules bacteria (*Rizobium leguminosarum bv.viciae*) as seed coating at the rate of 400g /fed.) on both sides of drippers lines (two seeds /hill) at 25 cm apart. At 15 days from sowing plants were thinned leaving one plant / hill.

Table 1: The soil physical and chemical properties of the experimental site during 2011/2012 and 2012/2013 seasons

Properties	2011/2012	2012/2013
Physical Properties		
Sand (%)	96.5	95.6
Silt (%)	1.7	1.6
Clay(%)	1.8	2.8
Texture	sandy	sandy
Chemical properties		
Organic matter (%)	0.03	0.08
PH	8.1	8.1
Available N (ppm)	5.4	6.9
Available P (ppm)	5.5	6.2
Available K (ppm)	52	64
Calcium carbonate (%)	0.18	0.26

Sample of the soil was obtained from 25 cm soil surface.

The experimental unit area was 10.5m^2 It contained 3 dripper lines with 5m length for each with 70cm wide plants of one dripper line (3.5m^2) for samples to measure the vegetative growth and N_2 fixation parameters and the other two dripper lines (7m^2) were used for yield determination (in the second part of this research). One dripper line was left between each two experimental units without spraying as a guard row to avoid the overlapping of spraying solution.

Active dry yeast (*Socchoromycu cervisiae*) at 5g and 10 g /L.was activated by using source of carbon and nitrogen according to Barnett *et al.,* (1990).

Seaweed extract (Alga 600Commercial product) was obtained from Leili Agrochemistry CO., LTD. It contains 65% organic matter, 1% N, 18% K2O, 2% S, 10% Alginic acid, 0.42% Mg and 0.30% Fe.

Humic acid Commercial product (Hammer) obtained from UAD Co, Union for Agricultural Development. It containts 86% humic acid, 6% K2O and 7% fulvic acid.

The foliar application treatments were sprayed twice during the growth period of plant at 30 and 40 days from sowing. Each experimental unit received 2L solution of active dry yeast, seaweed extract, humic acid and their mixtures using spreading agent (super film) in all treatments. The untreated plants (check) were sprayed with tap water with spreading agent.

All plots received equal amounts of compost at rate of 30m^3/feddan during soil preparation, without adding any chemical fertilizers during all the growing season.

The other recommended agricultural practices for commercial pea production were followed.

Data recorded:

The obtained data in this study were as follows.

A. Plant growth parameters:

Six plants from each plot were randomly taken at 50 days after sowing to evaluate the following vegetative characters: Plant height, number of branches/plant, number of leaves/plant and leaf area (cm^2/ plant).

B. Dry weight:

Different plant parts were oven dried at 70 ^{o}C till constant weight, and the following data were recorded: Dry weight of branches (g), leaves (g) and total dry weight/ plant (branches +leaves) g.

C. Root system traits:

The root of pea plants were carefully separated by washing the sand from them then the length of the main root, fresh weight of root (g), number and fresh weight of nodules.

D. Nitrogenas activity:-

The acetylene reduction assay (ARA) was measured as indicator to nitrogenase activity using the method of Hardly *et al.,* (1973). ARA values were expressed as μ moles C_2H_4 g^{-1} dry weight nodule h^{-1}.

E. Photosynthetic pigments:

Disk samples from the fourth upper leaf were taken at 50 days after sowing to determine chlorophyll a, b and total chlorophyll (a+b) as well as carotenoids according to Wettestein (1957).

F. Statistical analysis:

The data of this experiment were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1980) and the differences among means were compared using Duncan's multiple range test (Duncan, 1955),

RESULTS AND DISCUSSION

Vegetative growth

The results, listed in (Table 2) clearly show that foliar spray with some stimulant materials markedly affected pea plant height, number of leaves, number of branches and leaf area/ plant.

Plants treated with the mixture ADY at 10 g/l + SWE at 0.2% + HA at 0.2% produced the highest values of all growth parameters, followed by plants sprayed with the mixture of the three materials at the low concentration, with no significant differences between them. On the other side, the lowest values of vegetative growth were recorded by control treatment.

The beneficial effect of active dry yeast application on growth parameters of pea plants may be due to that yeast (*Saccharomyces cerevisiae*) as a stimulant source for cytokinins had stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophylls formation (Spencer *et al.,* 1983).

Seaweed extract contain major and minor nutrients, amino acids, vitamins, cytokinins, auxin and abscisic acid like growth promoting substances and have bean reported to stimulate the growth and of plants (Zhang *et al.,* 2003).

The stimulative effect of humic acid on growth parameters of pea plants may be due to that humic acid is one of the most active fractions of organic matter, it improves the absorption of nutrients by plants, stimulate plant respiration and the photosynthesis process, etc. (Brunetti *et al.,* 2007).

The enhancing effect of on pea growth may be due to that seaweed extract has applied to soil or sprayed on plants as fertilizer, which contain many growth regulators such as cytokines, 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).

Similar findings with active dry yeast foliar application were obtained by (El-Desuki and El-Gereadly 2006 and Abdel-Aziz and Zakher 2010) on pea, (Mohamed 2005, Nour and Eisa 2009) on snap bean, and (Ahmed and Gheeth 2013) on cowpea.

The obtained results with seaweed extract foliar nutrition agree with those reported by Temple and Bomke (1989) on bean, El – Aidy *et al.,* (2002) on sweet paper, Awad et al., (2006) on potato, Nour *et al.,* (2010) on tomateo.

In addition, the obtained results with humic acid foliar application are in a harmony with those reported by many researchers such as Senesi and Loffredo

Table 2

(1994), Khan *et al,.* (2012), Gad El-Hak *et al.* (2012) and Dawa *et al*., (2013) on pea, El-Bassiony *et al*. (2012); Hanafy *et al.,* (2010) on snap bean., (El-Hefny (2010); Azarpour *et al*., (2011) on cowpea.

Dry weight

The effect of foliar spray with some stimulant substances on dry weight of pea plants leaves, branches and total dry weight are shown in Table 3. It is evident from these results that foliar spray with all used materials enhanced dry weight of pea plants. The highest increases, in general, were obtained by the highest rate of the mixture among ADY, SWE and HA at 10g/l, 0.2% and 0.2% respectively, followed by the low concentration with no significant differences between them, while, the lowest values in this respect were recorded with untreated plants.

The enhancing effect of active dry yeast on dry weight of pea plants may be due to that yeast contains carbohydrate, amino acids and lipids as well as several vitamins and most nutritional elements; i.e. Na, Ca, Fe, Mg, K, P, S, Zn and Si Nagodawithana, (1991), Singaroval *et al.,* (1993) claimed that the increase in dry matter production with humic acid might be due to its direct action on auxin activity, contributing to increase plant growth and the dry matter.

Similar findings with active dry yeast foliar application were obtained by El-Desuki and El-Gereadly (2006) and Abdel-Aziz and Zakher (2010) on pea, Mohamed (2005), Nour and Eisa (2009) on snap bean, and Ahmed and Gheeth (2013) on cowpea.

The obtained results with seaweed extract foliar nutrition agree with those reported by Temple and Bomke (1989) on bean, El – Aidy *et al.,* (2002) on sweet paper, Awad *et al.,* (2006) on potato, Nour *et al.,* (2010) on tomato.

In addition, the obtained results with humic acid foliar application are in harmony with those reported by many researchers such as Senesi and Loffredo (1994), Khan *et al,.* (2012), Gad El-Hak *et al.* (2012) and Dawa *et al.* (2013) on pea, El-Bassiony *et al.* (2012); Hanafy *et al.* (2010) on snap bean, El-Hefny (2010); Azarpour *et al*., (2011) on cowpea.

Root system and nitrogenese activity

Presented data in Table 4 show that folier spray with (DAY at 10g/l + SWE at 2% + HA at, 2%) increased root length, dry weight of root, number of nodules, dry weight nodules and nitrogenase activity compared to control and other treatments This could be due to the simulative effect of the stimulant materials used in this study on enhancing plant growth, which encouraged growth of bacteria in rhizosphere including native rhizobia (Rashad and Ragab, 2003) and root hairs of plant (Antoun *et al*., 1998). On the other hand these results could be revealed that the effect of rhizobacteria on plant growth and N_2 fixation by producing growth regulator such as vitamins and indol acetic acid enhance plant nutrient and water uptake (Chebotar and *S.* Akoo, 2001 ; Ragab, and Rashad, 2003).

The enhancing effect of active dry yeast on pea root system my be due to the contains growth factors and a relatively larger proportion of free amino acids and short peptides of two or three amino acids plays a vital role in protein hydrolisates (Bevilacqua *et al.,*2008).

In addition 21-38% more root mass was observed in creeping bent grass by foliar application of sytokinin containing seaweed extract + humic acid under drought stress (Zhang and Ervin, 2004).

Photosynthetic pigments

Regarding the effect of ADY, SWE, HA and the mixtures among them, it is clear from the data in Table 5 that spraying pea plants with the mixture of ADY at 10 g/l + SWE at 0.2% + HA at 0.2% significantly enhanced photosynthetic pigments; i.e., chlorophyll a, b and total chlorophyll in the two tested seasons as compared to other treatments, while the highest values of carotenoids were recorded from untreated plants.

Table 3

Table 4

Table 5

The stimulative effect of active dry yeast on the chlorophyll content might be due to that yeast acts as a source of cytokinins (Skoog and Miller, 1957), which. delay the degradation of chlorophyll via the inhibition of chlorophylls (Ben, 1986).

The beneficial effect of seaweed extract on the chlorophyll content may be due to cytokinins and some nutrient materials content in seaweed extract, beside, nitrogen containing in the molecule structure of chlorophyll (Al-Sahaff, 1989).

Humic acid compounds may have various biochemical effects either at cell wall, membrane level or in the cytoplasm, including increased photosynthesis and respiration rates in plants (Chen and Aviad 1990). And also the significant positive effects of humic acid application were found on chlorophyll contents of soybean (Shuixiu and Ruizhen, 2001).

The obtained results with active dry yeast foliar application are in harmony with those reported by many researchers such as El-Desuki and El-Gereadly (2006) on pea Wanas (2002)on faba bean and Nour and Eisa (2009) on snap bean.

In addition, the obtained results with humic acid foliar application are in agree with those of Senesi and Loffredo (1994), Khan *et al,.* (2012), Gad El-Hak *et al*. (2012) and Dawa *et al*. (2013) on pea.

Conclusion

From the previous results of this investigation, it could be concluded that pea plants grown under similar growing conditions of this experiment sprayed with mixture of active dry yeast at 10g/l + seaweed extract at 0.2% + humic acid at 0.2% or with mixture of active dry yeast at 5g/l + seaweed extract at 0.1% + humic acid at 0.1% produce high plant growth, dry weight, root system trait and nitrogenase activity.

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تأثير الرش ببعض المواد المنشطة على نمو ونشاط انزيم النيتروجينيز فى نباتات البسلة

منال عبد الحميد مندور[١] ، عاطف عبد العزيز رجب[١] ، أميمه عثمان محمد[٢]

[١] المعمل المركزى للزراعة العضوية – مركز البحوث الزراعية

[٢] قسم بحوث تداول الخضر – معهد بحوث البساتين – مركز البحوث الزراعية

الملخص العربى

أجريت تجربتان حقليتان خلال فصل الشتاء لموسمى ٢٠١٢/٢٠١١ ، ٢٠١٢ / ٢٠١٣ فى مزرعة التجارب البحثية ، محطة بحوث البساتين بالقصاصين ، مركز البحوث الزراعية ، محافظة الأسماعيلية ، لدراسة تأثير الرش الورقى ببعض المواد الطبيعية (الخميرة الجافة النشطه ، مستخلص الأعشاب البحرية ، حمض الهيومك والمخاليط بينهم) على النمو ، الوزن الجاف ، قياسات المجموع الجذرى ،ونشاط انزيم النيتروجينيز و صبغات التمثيل الضوئى لنباتات البسلة صنف ماستر ب الناميه تحت ظروف الأراضى الرمليه مع استخدام نظام الرى بالتنقيط.

أدى رش نباتات البسلة بالخميرة الجافة النشطه بتركيز ٥ أو ١٠ جم / لتر ومستخلص الأعشاب البحرية بتركيز ٠.١ أو ٠.٢% وحمض الهيومك بتركيز ٠.١ أو ٠.٢% وكذلك معاملتى والمخاليط بينهم أدت إلى حدوث تأثير منشط على النمو الخضرى ، الوزن الجاف ، قياسات المجموع الجذرى ، ونشاط انزيم النيتروجينيز و صبغات التمثيل الضوئى مقارنة بالنباتات الغير معامله.

سجلت نباتات البسلة المعاملة بمخلوط من الخميرة الجافة النشطه بتركيز ١٠ جم /لتر + مستخلص الأعشاب البحرية بتركيز ٠.٢% + حمض الهيومك بتركيز ٠.٢% زيادة معنوية بالنسبة لكل من النمو الخضرى ، الوزن الجاف للأوراق والأفرع ، قياسات المجموع الجذرى ، ونشاط انزيم النيتروجينيز و صبغات التمثيل الضوئى ، تليها معاملة الرش بمخلوط من الخميرة الجافة النشطه بتركيز ٥ جم /لتر + مستخلص الأعشاب البحرية بتركيز ٠.١% + حمض الهيومك بتركيز ٠.١%.

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Table 2. Effect of foliar spray with some stimulant materials on morphological characters of pea plants at 50 days from sowing during 2011/2012 and 2012/2013 seasons

Characters / Treatments	Morphological characters / plant							
	Plant height (cm)		No. of leaves		No. of branches		Leaf area (cm^2/plant)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	40.33e	42.00f	10.67d	10.50f	2.00b	2.30b	180.2e	176.4g
ADY 5g/l	49.99c	49.00bc	12.77c	14.83cd	2.44ab	3.00ab	220.9d	255.1de
ADY 10g/l	49.99c	49.83ab	13.40bc	15.67b-d	2.55ab	3.00ab	234.5cd	270.9cd
SWE 0.1%	43.99d	43.33ef	12.52c	13.25e	2.33b	2.60ab	219.1d	230.6f
SWE 0.2%	45.25d	45.00de	12.41c	14.36de	2.33b	2.60ab	218.4d	252.7e
HA 0.1%	48.55c	47.16cd	13.85bc	15.88a-c	2.22b	2.50ab	241.1c	276.3bc
HA 0.2%	48.66c	48.83bc	14.00bc	16.11a-c	2.33b	2.80ab	242.2c	283.5bc
ADY at 5g/l + SWE at 1% + HA at 1%	52.99b	51.66a	14.55b	16.50ab	2.55ab	3.00ab	258.9b	290.4ab
ADY at 10g/l + SWE at2% + HA at 2%	54.97a	52.00a	16.66a	17.16a	3.00a	3.30a	291.6a	303.7a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test
ADY: active dry yeast, SWE : seaweed extract ,HA: humic acid

Table 3. Effect of foliar spray with some stimulant materials on dry weight of pea plants at 50 days from sowing during 2011/2012 and 2012/2013 seasons.

Characters / Treatments	Dry weight / plant(g)					
	Leaves		Branches		Total	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	6.24f	6.01f	5.98c	6.11f	12.22d	12.12g
ADY 5g/l	7.53cd	8.88ab	7.23b	8.06bc	14.76b	16.94b
ADY 10g/l	8.53b	8.85ab	6.75bc	7.95b-d	15.28b	16.80bc
SWE 0.1%	6.67ef	6.78e	6.20c	6.54ef	12.87cd	13.32f
SWE 0.2%	7.11de	7.55d	6.31c	7.18de	13.42c	14.73e
HA 0.1%	8.24bc	8.00c	6.37c	7.31c-e	14.61b	15.31de
HA 0.2%	8.80b	8.64b	6.65bc	7.29c-e	15.45b	15.93cd
ADY at 5g/l + SWE at 1% + HA at 1%	8.72b	9.11a	7.94a	8.88a	16.66a	17.99a
ADY at 10g/l + SWE at2% + HA at 2%	9.91a	9.25a	7.41ab	8.73ab	17.32a	17.98a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test
ADY: active dry yeast, SWE : seaweed extract ,HA: humic acid

Table 4. Effect of foliar spray with some stimulant materials on root system characters and nitrogenese activity of pea plants during 2011/2012 and 2012/2013 seasons .

Characters / Treatments	Root system/ plant								Nitrogenase activity	
	Root Length (cm)		Root Dry weight (g)		No. of nodules/plant		Nodules Dry weight / plant (g)		μ moles C_2H_4 g^{-1} (DW)nodule h^{-1}	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st Season	2nd season
Control	8.66e	9.44g	1.08f	1.11f	13.67g	14.11h	0.617e	0.648g	46.23f	49.26e
ADY 5g/l	12.33c	12.33d	1.35d	1.39de	14.45ef	14.78g	0.665cd	0.694e	45.43f	44.33g
ADY 10g/l	12.77bc	12.55cd	1.47c	1.54cd	15.81c	16.40cd	0.692bc	0.726d	55.92d	57.22c
SWE 0.1%	10.11d	10.22f	1.14ef	1.32e	14.11f	15.48f	0.641de	0.669f	48.59e	50.62d
SWE 0.2%	10.66d	11.00e	1.21e	1.41de	14.34f	15.91e	0.658d	0.691e	49.42e	45.45f
HA 0.1%	12.33c	12.66b-d	1.37d	1.45c-e	14.82de	16.11de	0.704b	0.741cd	53.22d	50.31d
HA 0.2%	12.77bc	13.00bc	1.50c	1.63c	14.91d	16.54c	0.711b	0.753c	50.33e	49.56e
ADY at 5g/l + SWE at 1% + HA at 1%	13.77b	13.33ab	2.11b	2.24b	16.29b	17.61b	0.764a	0.807b	57.40c	60.27b
ADY at 10g/l + SWE at2% + HA at 2%	15.88a	13.99a	2.25a	2.59a	17.82a	18.93a	0.788a	0.832a	60.52b	67.43a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test
ADY: active dry yeast, SWE : seaweed extract ,HA: humic acid.
*DW nodule = Dry weight nodules.

Table 5. Effect of foliar spray with some stimulant materials on Photosynthetic Pigments of pea plants during 2011/2012 and 2012/2013 seasons

Characters / Treatments	Photosynthetic Pigments							
	Chl.a mg/g F.W.		Chl.b mg/g F.W.		Total (a+b) mg/g F.W.		Carotenoids mg/g F.W.	
	1st season	2nd season	1st season	1st season	1st season	2nd season	1st season	2nd season
Control	5.20f	5.31f	4.35f	4.57f	9.55e	9.88f	4.83a	4.91a
ADY 5g/l	6.35c	6.44c	5.11bc	5.23b-d	11.46bc	11.67c	4.51b	4.56b-d
ADY 10g/l	6.66b	6.71b	5.03b-d	5.33a-c	11.69b	12.04b	3.16f	3.89g
SWE 0.1%	6.07d	6.11d	4.72de	4.86ef	10.79d	10.97d-e	4.27c	4.32d-f
SWE 0.2%	6.60b	6.66b	4.57ef	4.95de	11.17c	11.61c	3.41e	4.08fg
HA 0.1%	5.27f	5.68e	4.36f	5.11c-e	9.63e	10.79e	3.55de	4.16ef
HA 0.2%	5.71e	5.83e	4.87c-e	5.37a-c	10.58d	11.20d	3.72d	4.39c-e
ADY at 5g/l + SWE at 1% + HA at 1%	7.46a	7.66a	5.46a	5.50ab	12.95a	13.16a	4.39bc	4.72ab
ADY at 10g/l + SWE at2% + HA at 2%	7.56a	7.73a	5.21ab	5.67a	12.77a	13.40a	4.21c	4.57bc

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test
ADY: active dry yeast, SWE : seaweed extract ,HA: humic acid