RESEARCH ARTICLE

SABRAO Journal of Breeding and Genetics
56 (5) 2119-2126, 2024
http://doi.org/10.54910/sabrao2024.56.5.34
http://sabraojournal.org/
pISSN 1029-7073; eISSN 2224-8978

EFFECT OF SEAWEED EXTRACT AND NITROGEN FERTILIZER ON THE GROWTH AND YIELD TRAITS OF PEA (*PISUM SATIVUM* L.)

M.H.K. AL-MAJDI[1*], N.H.N. ALABOJAML[1], and D.H. MEHDI[2]

[1]College of Agriculture, Al-Qasim Green University, Al-Qasim, Iraq
[2]Ministry of Agriculture, Baghdad, Iraq
Corresponding author's email: mustafa.hameed@agre.uoqasim.edu.iq
Email addresses of co-authors: noora.hade@agre.uoqasim.edu.iq, douaa37576@gmail.com

SUMMARY

The concerned study determined the effects of foliar application of nitrogen fertilizer - urea (N 46%) levels (0, 5, 10, and 15 gm L^{-1}) and seaweed extract (0, 2, 4, and 6 ml L^{-1}) on the vegetative growth and yield traits of pea (*Pisum sativum* L.), carried out in autumn of 2022 in Babylon Province, Iraq. The results indicated significant superiority of the seaweed treatment (6 ml L^{-1}) in enhancing the pea's vegetative growth and yield. The seaweed treatment of 6 ml L^{-1} provided the highest averages for plant height (57.60 cm), branches per plant (12.58), leaves per plant (26.88), leaf area (925.83 cm^2), chlorophyll content (47.95 SPAD), vegetative dry weight (49.68 g), pods per plant (13.83), pod weight (14.10 g), pod yield per plant (196.90 g), and seeds protein (22.15%) compared with lowest values obtained in the control treatment. The foliar application of urea (15 gm L^{-1}) followed the seaweed and showed the second-highest averages for the above parameters (56.10 cm, 12.08, 25.77, 888.10 cm^{-2}, 46.20 SPAD, 48.23 g, 12.93, 14.08 g, 184.31 g, and 21.45%, respectively). The interaction of seaweed (6 ml L^{-1}) and nitrogen fertilizer (15 gm L^{-1}) was superior, with the highest averages for the said traits.

Keywords: Pea (*Pisum sativum* L.), seaweed extract, urea fertilizer, foliar fertilization, vegetative growth, yield traits, chlorophyll and protein content

Key findings: The foliar application seaweed extract and urea fertilizer, individually and in combination, performed better for the growth, morphological, yield, and biochemical traits.

Communicating Editor: Dr. Quaid Hussain

Manuscript received: November 16, 2023; Accepted: April 11, 2024.
© Society for the Advancement of Breeding Research in Asia and Oceania (SABRAO) 2024

Citation: Al-Majdi MHK, Alabojaml NHN, Mehdi DH (2024). Effect of seaweed extract and nitrogen fertilizer on the growth and yield traits of pea (*Pisum sativum* L.). *SABRAO J. Breed. Genet.* 56(5): 2119-2126. http://doi.org/10.54910/sabrao2024.56.5.34.

INTRODUCTION

The pea (Pisum sativum L.) plant belongs to the family Leguminosae, a native to Europe and Western Asia. It is also probable that areas of Al-Habasha, belonging to Ethiopia and Eritrea, are the prime centers for nutritious peas. The pea crop ranked third (for area) and has the sixth position (for production) among the winter vegetable crops (Mulk and Khan, 2013). Peas also ranked third for their nutritional values among vegetable crops, as every 100 g of green pea seeds contain water (74.3 g), protein (6.7 g), calcium (220 mg), vitamin A units (700), ascorbic acid (28 mg), thiamine (0.25 mg), riboflavin (0.15 mg), and niacin (2.10 mg) (Matloub et al., 1989).

Fertilizers affect crop plants' growth and yield parameters. The recommended fertilization is one of the crucial factors due to its effects on the vital processes and interactions that occur within the cellular system and its implications for improving plant growth and yield. Foliar fertilization is also one of the essential factors affecting various physiological processes within crop plants, managing the vegetative growth and yield components (Al-Tayeb, 2012).

Nitrogen is one of the primary elements in plant nutrition. It participates in the chlorophyll molecule synthesis and formation of proteins, nucleic acids, plant hormones, and energy compounds. The nitrogen availability for the crop plant contributes to enhancing production and improving its quality (Mengel and Kirkby, 1987). Crop plants can absorb the urea fertilizer solution through foliar application; therefore, this technique can benefit numerous plant groups with different agricultural systems (Nicoulaud and Bloom, 1996). Wahle and Masiunas (2003) reported that the fertilization strategy of spraying urea on plants aims to fortify with nutrients to obtain ideal growth and yield.

Nitrogen plays a critical role within the plant, especially in activating numerous enzymes that trigger the chief compounds involved in forming energy production compounds (ATP) (Daur et al., 2008). The ATP itself is an influential compound in photosynthesis and the transfer of nutrients from the source to downstream, reflecting positively on the percentage of protein in the plants and seeds. Plant seedlings, especially vegetables with ideal vegetative growth, can face stressful conditions while planted in the field (Mohamed et al., 2010). Therefore, some qualitative characteristics must be available to provide seedlings to withstand those conditions, including increasing the plant's nutrient element absorption ability. Foliar fertilization application using urea seeks to reduce nitrogen deficiency and almost gives the same response to crop plants as provided by ground fertilization (Morgan, 2013).

Seaweed extracts, as commonly used foliar fertilizers, are a good source of various nutrient and growth regulator types, improving growth and yield traits in crop plants (O'Dell, 2013). It may refer to the high percentage of available cytokinin, which encourages cell division. Jensen (2014) reported that seaweed extract contains various micronutrients (Co, B, Mo, Zn, Cu) in addition to the macronutrients. These extracts also contain auxins, gibberellins, and cytokinins, which enhance the ability of roots to grow and absorb nutrients. Increasing the thickness and strength of stems with increased leaf area enhances the vegetative and root growth, resulting in increased yield. In a study on rosemary plants, foliar application of seaweed extract caused a significant increase in most of the vegetative growth characteristics (Abascal and Yarnell, 2011). The findings of Temple and Bomke (2009) revealed that adding natural seaweed extracts as foliar fertilizers to legumes (peas and soybeans) led to a yield increase of 24% compared with untreated plants.

Al-Shammari (2011) found that spraying the cowpea plant with the Algamex marine extract (3 ml L^{-1}) gave the highest leaf area and weight of root nodules. Therefore, the presented study sought to determine the extent of the local pea cultivar's response to the foliar application of seaweed extract and urea fertilizer on growth and yield traits.

MATERIALS AND METHODS

The practical study aimed to determine the effects of foliar application of urea fertilizer (N 46%) levels (0, 5, 10, and 15 gm L^{-1}) and seaweed extract levels (0, 2, 4, and 6 ml L^{-1}) on the vegetative growth and yield parameters of the local pea cultivar (Pisum sativum L.). The field experiment commenced in the autumn of 2022 in the Altahriya region, Babylon Province, Iraq (altitude 32° 36′ 59″ N, longitude 44° 22′ 25″ E).

The field land's plowing used a flip plow in two perpendicular plows, followed by smoothing, leveling, and dividing into terraces with a length of 4 m and a distance of 75 cm between them. Before planting the pea seeds, a calibration plot transpired to determine the planting line. The seeds' planting occurred on October 25, 2022, in holes at a distance of 25 cm, with 3–4 seeds placed per hole. After germination, plant thinning per plant continued. Recommended field operations happened from the beginning of planting until the end of harvesting operations, including thinning, weeding, and hoeing operations and irrigation whenever necessary. Pea plants received fertilization with phosphate fertilizer (triple superphosphate 21% P2O5) at the rate of 120 kg ha^{-1} and potassium fertilizer in the form of potassium sulfate (41.5% k2O) at the rate of 100 kg ha^{-1}. Phosphate fertilizer addition emerged during the experiment's soil preparation, while potassium fertilizer was after two weeks from germination, as a groove, and along the length of the soil (Matloub et al., 1989).

Several random soil samples came from the experimental field at a depth of 0–30 cm and reached mixing to estimate soil characteristics. The soil texture estimation followed the method according to Jackson (1958), with available nitrogen and phosphorus estimated according to Black (1965). The available potassium estimation ran through the Flame Photometer (Black, 1965; Olsen and Sommers, 1982). Measurement of pH, degree of electrical conductivity, calcium carbonate, bulk density, and exchange capacity employed the procedure of Black (1965), while EC engaged the approach of Richards (1954) (Table 1).

The harvest of pea plants was on April 25, 2023, and studying all the required plant characteristics followed. Ten randomly selected plants from the central rows in each experimental unit had their data recorded for the plant height, branches per plant, leaves per plant, leaf area, dry weight of the plant, leaf chlorophyll content, pods per plant, pod weight, yield per plant, and seed protein content. The experiment proceeded in a randomized complete block design (RCBD). Mean differences comparison and separation used the least significant difference ($LSD_{0.05}$) test (Al-Rawi and Khalaf-Allah, 2000).

Table 1. Soil characteristics of experimental study.

Soil characteristics	Units	Values
ECE	dS m^{-1}	2.8
pH	-------	7.8
Organic matter	g kg^{-1}	9.4
$CaCO_3$		226
CEC	Cmole kg^{-1} soil	21.3
Available N		27.6
Available P	mg kg^{-1} soil	8.5
Available K		132.7
Bulk density	g cm^{-3}	1.42
Sand		322.5
Silt	g kg^{-1}	437.8
Clay		239.7
Texture	Clay Loam	

Table 2. Effect of seaweed and Urea foliar application on the plant height and branches per plant in peas.

Seaweed	Plant height (cm)				Means (cm)
	Urea (g L^{-1})				
	0	5	10	15	
0	40.1	41.8	43.7	46.2	42.95
2	42.4	45.9	48.3	52.6	47.30
4	44.7	48.2	53.6	58.1	51.15
6	49.5	55.4	59.2	67.5	57.60
Means (cm)	44.18	47.83	51.20	56.10	
$LSD_{0.05}$ Seaweed: 3.48, Urea: 3.48, Interaction: 6.45					
	Branches plant^{-1}				Means (#)
0	7.1	7.9	9.2	9.8	8.50
2	8.1	8.9	10.1	11.2	9.58
4	9.2	10.5	11.8	12.9	11.10
6	10.6	12.1	13.2	14.4	12.58
Means (#)	8.75	9.85	11.08	12.08	
$LSD_{0.05}$ Seaweed: 0.72, Urea: 0.72, Interaction: 1.44					

RESULTS AND DISCUSSION

The effects of foliar application of seaweed extract and urea fertilizer underwent assessment for growth and yield traits in the local cultivar of pea (Pisum sativum L.), as discussed herein.

Plant height and branches

The results revealed significant differences among the varying applied levels of seaweed extract and urea fertilizer for the plant height and the number of branches per plant in pea (Table 2). The seaweed extract (6 ml L^{-1}) excelled and provided the highest average plant height (57.60 cm) and the number of branches per plant (12.58) compared with the control treatment with the lowest averages for the said traits (42.95 cm and 8.50, respectively). As for urea spraying, the urea treatment (15 gm L^{-1}) was significantly superior showing the foremost average for plant height (56.10 cm) and branches per plant (12.08) versus the control treatment (44.18 cm and 8.75, respectively). As for the interaction between the two factors, the combined application of seaweed (6 ml L^{-1}) and urea (15 g L^{-1}) showed the maximum averages for plant height and branches per plant (67.5 cm and 14.4, respectively) compared with the control treatment, recording the lowest values for the said traits. The interaction treatment also excelled in the individual foliar application of seaweed extract and urea fertilizer in pea crops.

Leaves plant^{-1} and chlorophyll content

Meaningful differences were notable among the different seaweed extract and urea fertilizer levels for leaves per plant and chlorophyll content (Table 3). The seaweed extract treatment (6 ml L^{-1}) excelled and showed the most number of leaves per plant (26.88) and chlorophyll content (47.95 SPAD) compared with the control treatment that exhibited the lowest averages for both traits (18.93 and 36.40 SPAD, respectively). As for urea foliar application, the urea treatment (15 gm L^{-1}) was significantly superior by displaying the utmost number of leaves and chlorophyll content (25.77 and 46.20 SPAD, respectively) compared with the control treatment with the minimum averages for the said traits (19.83 and 37.90 SPAD, respectively). The combined application of seaweed extract (6 ml L^{-1}) and urea (15 g L^{-1}) was superior in leaves per plant and chlorophyll content (31.4 and 53.8 SPAD, respectively) versus the control treatment, with the lowest averages for both traits**.**

Table 3. Effect of seaweed and Urea foliar application on leaves per plant and chlorophyll content in peas.

Seaweed	Leaves plant^{-1} Urea (g L^{-1})				Means (#)
	0	5	10	15	
0	16.2	17.8	19.5	22.2	18.93
2	17.9	20.4	21.8	24.1	21.05
4	21.4	23.1	23.7	25.2	23.35
6	23.8	24.9	27.4	31.4	26.88
Means (#)	19.83	21.55	23.10	25.77	
$LSD_{0.05}$ Seaweed: 2.15, Urea: 2.15, Interaction: 4.08					
	Leaf chlorophyll content (SPAD)				Means (SPAD)
0	32.7	35.6	37.2	40.1	36.40
2	36.5	38.4	41.2	43.1	39.80
4	39.1	42.2	44.7	47.8	43.45
6	43.3	45.8	48.9	53.8	47.95
Means (SPAD)	37.90	40.50	43.00	46.20	
$LSD_{0.05}$ Seaweed: 3.04, Urea: 3.04, Interaction: 6.08					

Table 4. Effect of seaweed and Urea foliar application on the leaf area and plant vegetative dry weight in peas.

Seaweed	Leaf area (cm^2) Urea (g L^{-1})				Means (cm^2)
	0	5	10	15	
0	583.2	640.8	702.0	799.2	681.30
2	658.8	694.2	755.2	812.7	730.23
4	748.6	831.9	869.5	934.4	846.10
6	858.6	892.5	945.3	1006.1	925.63
Means ($cm^{2)}$	712.30	764.85	818.00	888.10	
$LSD_{0.05}$ Seaweed: 37.32, Urea: 37.32, Interaction: 48.41					
	Plant vegetative dry weight (g)				Means (g)
0	34.6	35.8	37.5	40.1	37.00
2	36.9	38.4	43.2	44.9	40.85
4	40.5	44.7	47.8	52.2	46.30
6	43.7	48.2	51.1	55.7	49.68
Means (g)	38.93	41.78	44.90	48.23	
$LSD_{0.05}$ Seaweed: 2.87, Urea: 2.87, Interaction 5.74					

Leaf area and biomass dry weight

The results enunciated remarkable differences among the different applied levels of seaweed extract and urea fertilizer for leaf area and biomass dry weight (Table 4). The seaweed treatment (6 ml L^{-1}) surpassed and revealed the highest average for leaf area (925.83 cm^2) and vegetative dry weight (49.68 g) compared with the control treatment observed with the lowest averages for the said traits (681.30 cm^2 and 37.0 g, respectively). The urea treatment (15 gm L^{-1}) was also considerably superior, providing maximum values for leaf area and dry biomass (888.10 cm^2 and 48.23 g, respectively) versus the least values obtained in the control treatment (712.30 cm^2 and 38.93 g, respectively). The interaction of both factors (seaweed extract 6 ml L^{-1} + urea 15 g L^{-1}) led to the highest averages for leaf area and vegetative dry weight (1006.1 cm^2 and 55.7 g, respectively) compared with the control treatment and the individual application of seaweed extract and urea fertilizer.

Table 5. Effect of seaweed and Urea foliar application on pods per plant and pod weight in peas.

Seaweed	Pods plant^{-1} Urea (g L^{-1})				Means (#)
	0	5	10	15	
0	7.2	7.9	9.1	9.8	8.50
2	8.1	9.5	10.2	11.5	9.83
4	10.2	11.5	12.9	14.1	12.18
6	11.7	13.2	14.1	16.3	13.83
Means (#)	9.30	10.53	11.58	12.93	
$LSD_{0.05}$ Seaweed: 0.76, Urea: 0.76, Interaction: 1.52					
	Pod weight (g)				Means (g)
0	10.3	10.8	12.1	12.8	11.50
2	10.9	11.3	12.9	13.8	12.23
4	11.5	12.2	13.4	14.1	12.80
6	12.3	13.8	14.7	15.6	14.10
Means (g)	11.25	12.03	13.28	14.08	
$LSD_{0.05}$ Seaweed: 0.65, Urea: 0.65, Interaction: 1.30					

Pods and pod weight plant^{-1}

The outcomes revealed substantial variances among the seaweed extract and urea fertilizer levels for pods per plant and pod weight (Table 5). The application of seaweed extract (6 ml L^{-1}) exhibited the highest average of pod number (13.83) and pod weight (14.10 g) compared with the control treatment, which provided the lowest values for said traits (8.50 and 11.50 g, respectively). As for urea foliar application, the urea treatment of 15 gm L^{-1} was significantly superior, giving the most number of pods and pod weight per plant (12.93 and 14.08 g, respectively) versus the control treatment for the said traits (9.30 and 11.25 g, respectively). On the interaction of both factors, the combined application (seaweed extract 6 ml L^{-1} + urea 15 g L^{-1}) displayed the maximum averages for number of pods and pod weight per plant (16.3 and 15.6 g, respectively) compared with the individual application of seaweed extract and urea application and the control treatment, recording with the lowest averages for the said traits.

Pod yield and seed protein content

The results revealed significant differences among the varying levels of seaweed extract and urea fertilizer for pod yield and seed protein content (Table 6). The seaweed extract treatment (6 ml L^{-1}) showed the highest average for pod yield per plant (196.90 g) and the seed protein content (22.15%) compared with the control treatment, observed with the lowest averages for the said traits (98.76 g and 16.38%, respectively). On the urea foliar application, the urea treatment of 15 gm L^{-1} was notably superior, giving the utmost averages for pod yield and seed protein content (184.31 g and 21.45%, respectively) compared with the control treatment that showed the lowest averages for both traits (105.92 g and 17.45%, respectively). Regarding the interaction of both factors, the combination of seaweed extract (6 ml L^{-1}) and urea (15 g L^{-1}) excelled in the individual application of seaweed extract and urea fertilizer and the control treatment by demonstrating the maximum values for pod yield per plant and seed protein content (254.3 g and 24.6%, respectively).

The outcomes showed that the combined application of seaweed extract (6 ml L^{-1}) and urea fertilizer (15 g L^{-1}) excelled in the individual application of seaweed extract and urea fertilizer and the control treatment by providing the highest values for all the vegetative growth and yield-related traits and the seed protein content in pea plants. The reason may be due to the urea fertilizer solution and the effect of the nitrogen element performing better to enhance the activity of gibberellins within plant tissues. These growth activities further promote cell division, which

Table 6. Effect of seaweed and Urea foliar application on the pod yield per plant and protein content in peas.

Seaweed	Pod yield plant^{-1} (g)				Means (g)
	Urea (g L^{-1})				
	0	5	10	15	
0	74.16	85.32	110.1	125.4	98.76
2	88.29	107.4	131.6	158.7	121.50
4	117.3	140.3	172.9	198.8	157.30
6	143.9	182.2	207.3	254.3	196.90
Means (g)	105.92	128.78	155.46	184.31	
$LSD_{0.05}$ Seaweed: 21.13, Urea: 21.13, Interaction: 42.26					
	Protein (%)				Means (%)
0	15.3	15.9	16.4	17.9	16.38
2	16.2	17.6	18.9	20.5	18.30
4	18.2	19.5	21.7	22.8	20.55
6	20.1	21.4	22.5	24.6	22.15
Means (%)	17.45	18.60	19.88	21.45	
$LSD_{0.05}$ Seaweed: 1.36, Urea: 1.36, Interaction: 2.72					

affects the vegetative growth characteristics, such as plant height, number of branches, number of leaves, leaf area, and plant dry weight, consequently improving yield-related traits and quality (Lucas et al., 2008).

The nitrogen element contributes to stimulating and increasing the production of plant hormones, such as auxins and cytokinins, which work to boost plant cell division and increase the formation of leaf rudiments, raising the construction of nucleic acids and the manufacture of proteins that stimulate the process of cell division (Taiz and Zeiger, 2006). Nitrogen foliar application increasing the leaf chlorophyll might be due to the formation of porphyrins, essential in building chlorophylls and cytochromes and crucial for photosynthesis and respiration (Yin et al., 2011; Sardana et al., 2007; Singh et al., 2015; Jaafar et al., 2022).

The increase in yield components due to nitrogen is due to its contribution to prolonging the period of grain filling by keeping the plant leaves active for an extended period and enhancing the manufactured material transported to their storage places in the grains (Kocon, 2010). The reason for the effect of nitrogen in increasing the protein content of seeds is that the said macro-element contributes to elevating the construction of amino acids and some enzymatic accompaniments that lead to increased protein synthesis (Taub and Wange, 2008). The presented results were also consistent with past findings by studying the effects of organic fertilizer and nitrogen addition in bean plants (Kamal et al., 2016).

The significant superiority of adding biofertilizer and seaweed extract, which also considerably enhanced the studied parameters, may refer to the high percentage of available cytokinin, which encourages cell division and expansion. Moreover, Jensen (2014) stated that seaweed extracts contain numerous micronutrients (Co, B, Mo, Zn, Cu) with macronutrients. They also contain auxins, gibberellins, and cytokinins, and with their foliar application, they increase roots to grow and absorb more nutrients. The seaweed extracts enhance the thickness and strength of the stem and leaf area, thus enhancing the vegetative and root growth, resulting in increased pod yield in peas.

CONCLUSIONS

The combined foliar application of seaweed extract (6 ml L^{-1}) and urea fertilizer (15 gm L^{-1}) considerably improved all the vegetative growth and yield-related traits and seed protein content compared with their separate application and the control treatment in peas.

REFERENCES

Abascal K, Yarnell E (2011). Herbs and Breast Cancer. Research review of seaweed rosemary and ginseng. *Alternat. Complement. Therapies* 7(1): 32–36.

Al-Rawi KM, Khalaf-Allah AAM (2000). Design and analysis of agricultural experiments. National Library for Printing and Publishing, University of Mosul, Iraq.

Al-Shammari WSA (2011). The effect of the biofertilizer EM1 and marine algae extracts on growth and yield of cowpeas (*Vigna unguiculata* L.) Master's Thesis, Department of Horticulture, College of Agriculture, Tikrit University, Ministry of Higher Education and Scientific Research, Republic of Iraq.

Al-Tayeb FAS (2012). Evaluating the effect of some biological factors on the growth and productivity of spinach *Spinacia oleracea* L. A local variety and its content of calcium oxalate crystals. Ph.D. Thesis. College of Agriculture, University of Kufa, Iraq.

Black CA (1965). Methods of soil analysis. Part 2. *Am. Soc. Agro.* Madison, Wisconsin, USA.

Daur I, Sepetoglu H, Marwarth KB, Hassan G, Khan IA (2008). Effect of different levels of nitrogen on dry matter and grain yield of green gram. *Pak. J. Bot*. 40(6): 2453–2459.

Jaafar HS, Abd AA, Al-Bayati AS (2022). *Vicia faba* L. assessment for growth and productivity traits under magnetized irrigation water and nano-seaweed extract. *SABRAO J. Breed. Genet.* 54(5): 1216-1222. http://doi.org/ 10.54910/sabrao2022.54.5.22.

Jackson ML (1958). Chemical Analysis Prentice. Hall Inc. Englewood Cliffs, N.J., USA.

Jensen E (2014). Seaweed; fact or fancy. From the organic broadcaster. *Soil Science J.* 12(3):164–170.

Kamal JAK, Al-Abbasi GBA, Salman FS (2016). The effect of adding fertilizer organic matter and urea in the growth and yield of bean plants. *Babylon Uni. J. Pure Appl. Sci.* 24(4): 991–1002.

Lucas DM, Daviere JM, Falon MR, Potin M, Iglesias M (2008). A molecular framework for light and gibberellins control of cell elongation. *Nature* 451: 480–484.

Matloub AN, Muhammad IS, Abdul KS (1989). Vegetable Production. Directorate of Dar Al-Kutub for Printing and Publishing, University of Al-Mosul, Iraq.

Mengel K, Kirkby EA (1987). Principles of Plant Nutrition. 4th Edition. International Potash Institute, Basel, Switzerland.

Mohamed AN, Ismail MR, Rahman MH (2010). In vitro response from cotyledon and hypocotyls explants in tomato by inducing 6- benzylaminopurine. *Afr. J. Biotechnol*. 9(30): 4802–4807.

Morgan L (2013). Troubleshooting in the hydroponic garden. *Maximum Yield*, September 22-23.

Mulk SU, Khan M (2013). Comparative advantage and competitiveness of pea crop in Khyber Pakhtunkhwa. *Sarhad J. Agric*. 29(2): 299–306.

Nicoulaud BAL, Bloom AJ (1996). Absorption and assimilation of foliarly applied urea in tomato. *J. Am. Soc. Hortic. Sci.* 121: 1117–1121.

O'Dell C (2013). Natural plant hormones are biostimulants helping plant vegetable, small fruit and specialty crops. *Plant Ecol. J.* 25(12): 245–249.

Olsen SR, Sommers LE (1982). Methods of Soil Analysis. Part 2, Agron. Monogr. Madison. Phosphorus. P. 403–430.

Richards LA (1954). Diagnosis and Improvement of Saline and Alkali Soils. USDA, USA, Handbook No. 60.

Sardana S, Mahajan RK, Gautam NK, Ram B (2007). Genetic variability in pea (*Pisum sativum* L.) germplasm for utilization. *SABRAO J. Breed. Genet.* 39(10): 31-41.

Singh J, Dhall RK, Aujla IS (2015). Characterization of resistance response of garden pea (Pisum sativum L.) against powdery mildew (*Erysiphe pisi* dc) in sub-tropical plains of India. *SABRAO J. Breed. Genet*. 47(4): 384-393.

Taiz L, Zeiger E (2006). Plant Physiology. 4th Ed. Sinauer Associates, Inc. Publisher Sunderland, Massachusetts- AHS. USA. pp. 764.

Taub DR, Wang XZ (2008). Why are nitrogen concentration in plant tissues lower under elevated CO2? A critical examination of the hypotheses. *J. Integr. Plant Biol.* 50: 1365–1374.

Temple WD, Bomke AA (2009). Effects of Kelp (*Macrocystis integrifolia* and *Ecklonia maxima*) foliar applications on bean crop growth. *Plant Soil J.* 117: 85–92.

Wahle EA, Masiunas JB (2003). Population density and nitrogen fertility effects on tomato growth and yield. *Hort. Science.* 38(3): 367–372.

Yin L, Hu T, Xie C, Feng Y, Yan Z, Li Y, Wang Y (2011). Effect of nitrogen application rate on growth and leaf photosynthetic characteristics of *Jatropha curcas* L. seedlings. *Acta Ecol. J.* 31: 4977–4984.