

## **EFFECT OF COMPOUND FERTILIZER APPLICATION RATES ON VEGETATIVE GROWTH, TOTAL YIELD AND HEAD QUALITY OF LETTUCE**

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### **ABSTRACT**

The growth, yield, head quality and NPK contents in lettuce plants grown on a sandy soil fertilized with different rates (0, 75 and 150 gm m<sup>-2</sup>) of 18:7:16 NPK compound fertilizer was evaluated in an experiment conducted for two successive seasons (1998/1999 and 1999/2000). As compared with the control, fertilized treatments showed significant differences in fresh weight per plant, percentage dry/fresh weight, leaf area, total yield, head diameter and head circumference for the two seasons. After harvest, the contents of NPK in the lettuce leaves and the soil were increased by the application of the compound fertilizer at a rate of 150 gm/m<sup>2</sup>. However, the increase in P % in both lettuce leaves and soil was not significant for all treatments.

### **INTRODUCTION**

Lettuce plant (*Lactuca sativ* L.) is one of the most popular leafy grown in King of Saudi Arabia. Al-Hassa oasis is one of the largest agricultural areas in the Kingdom. In general light textured soil is usually deficient of the macro-elements, especially nitrogen (N) and phosphorus (P) (Al-Taher, 1999). Many investigators showed that the application of these nutrients had positive effects on the growth characters and yield of lettuce.

Vidigal *et al.* (1997) found that the yield of lettuce from the treatments at which organic materials from different sources were mixed with 750 kg of NPK fertilizer (4:14:8) plus 60 kg N of urea per ha. was better than that from the treatments without organic materials. Also, in an experiment started from 1966 to investigate different fertilization programs consisting of organic, inorganic (NPK) or combination treatments. Gianquinto *et al.* (1992) mentioned that nitrate contents on a babies of lettuce grown in spring was the lowest compared with tomatoes, spinach, kohlrabi and autumn-grown lettuce. They also indicated that nitrate content was increased by mineral fertilization and decreased by manuring, compared with control treatment. Sekimoto *et al.* (1997) found that plant growth of lettuce was doubled with sufficient nutrient of the NPK using a simple hydroponics system. Nicoulaud *et al.* (1990) reported that dry matter yield and nutrient uptake were improved by the application of NPK fertilizer mixed with a poultry manure as compared with applications of single mineral fertilizers.

In studies carried out from 1986 to 1988, Sanchez *et al.* (1991) observed that the highest yield of lettuce was found by the application of NPK fertilizer at the full-recommended rate uniformly applied to the soil surface as suspension 1 week before sowing. In the same study, a sidedress of NPK fertilizers applied 1, 2, 3 and 4 weeks after thinning of seedlings at the 4 leaf

stage was also investigated. The results of the trial showed that there was no significant increase in yield at any of the 4 sites investigated.

In greenhouse trials on 10 lettuce cultivars, Santos *et al.* (1997) suggested that the cultivars showed significant differences in their response to the fertilization practices that included the application of organic urban waste with mineral NPK. The differences were in leaf fresh and dry weight and root dry weight. Arshavskaya *et al.* (1992) suggested that NPK fertilizations had different effects on the characteristics of lettuce plants and the soil where they were grown on. Belligno *et al.* (1997) conducted an experiment testing the effects of N from different sources on lettuce plants grown on a sandy soil. The N sources were 0, 100, 200 or 300 kg N as urea,  $\text{NH}_4\text{NO}_3$ , a 28:14 NP fertilizer or a 15:24:12 NPK fertilizer. The N in NP and NPK was supplied as 50 %  $\text{NH}_4\text{NO}_3$  and 50 % oxamide. The investigators indicated that all fertilizer applications caused a significant increase in the weights of the heads of lettuce plants. They also observed that the best N efficiency was obtained with the NPK fertilizer.

The objectives of this study are to investigate the effects of compound fertilizer (NPK) on the vegetative growth, leafy yield and quality of lettuce plants, and the NPK contents of their leaves and the soil under the dry conditions of the Al-Hassa oasis.

## MATERIALS AND METHODS

A field experiment was carried out for the two successive seasons of 1998/1999 and 1999/2000 at the Agricultural and Veterinary Training and Research Station, King Faisal University, Al-Hassa, KSA. 30 days Lettuce seedlings (White Bosten cultivar) were used in this experiment. They were transplanted on the 3<sup>rd</sup> and 7<sup>th</sup> of December 1998 and 1999, respectively. The experiment was completed in an open field of a sandy soil. The following Table includes the major physical and chemical properties of the experimental site, which determined following methods described by Rowell (1994).

Soil Character	Soil texture				EC dS m <sup>-1</sup>	pH	N (%)	Ava. P# (ppm)	CaCO <sub>3</sub> (%)
	sand	silt	clay	class					
values	96%	2%	2%	sandy	1.6	7.8	0.002	5	7

**Keys: # refers to available phosphorus in the upper 50 cm of the field.**

The fertilizer treatments in the experiment are two levels of the NPK compound fertilizer (18% nitrogen, 7 % phosphorus and 16 % potassium, respectively). The levels were 75 and 150 gm per m<sup>2</sup>. A control treatment (i.e., without fertilizer) was also included. The N used in the NPK fertilizer consisted of 2.69 %  $\text{NH}_4\text{-N}$ , 7.33 %  $\text{NO}_3\text{-N}$  and 5.98 % uric-N. In the meantime, the P and K were in the forms  $\text{P}_2\text{O}_5$  and  $\text{K}_2\text{O}$ , respectively. The experiment was completed following a complete randomized block design with four replicates. Each plot had an area of 12 m<sup>2</sup>, which was divided into 4 rows with 6 m length and 50 cm width. The spacing between the plants was 25 cm. All plots were irrigated following the method of surface irrigation. The

irrigation water had a salinity of 2.1 dS m<sup>-1</sup> and a sodium absorption ratio (SAR) of 4.65.

After harvest, some measurements on the plants were done to determine the effects of fertilizer treatments on the vegetative growth, total yield and head quality of grown plants of lettuce. The measurements were completed on a representative sample of 5 plants randomly chosen from each plot. They include fresh weight per plant, dry / fresh weight ratio (%), leaf area of outer leaves per squared meter, head diameter (cm), head circumference (cm) and total yield per squared meter. Also, the plant and soil contents of nitrogen, phosphorus and potassium were determined following the methods described by Page *et al.* (1982).

All data obtained were subjected to statistical analysis according to the procedure outlined by Gomez and Gomez (1983). All cultural practices were done according to the recommendation of Ministry of Agriculture and Water.

## RESULTS AND DISCUSSION

### Vegetative parameters:

Data in Table (1) show that the application of the compound fertilizer (NPK) significantly increased the fresh weight, percentage dry / fresh weight ratio, leaf area, total yield, head diameter and head circumference as compared with the control treatment for the average of the two seasons. The highest values of these parameters were found with the NPK fertilization rate of 150 gm m<sup>-2</sup>, which showed significant increases over the other treatments with exceptions for the percentage dry / fresh weight ratio and head circumference. Similar results were obtained by Nicoulaud *et al.* (1990), who observed that plant dry matter and yield of lettuce were increased with the NPK fertilization. Sanchez *et al.* (1991) also found that the yield of lettuce crop significantly increased with the application of NPK at the rate of 44.8 kg, 60.5 P<sub>2</sub>O<sub>5</sub> kg and 12.3 K<sub>2</sub>O kg per hectare. Other investigators reported comparable results (Gianquinto *et al.*, 1992; Belligno *et al.*, 1997; Chen *et al.*, 1997; Santos *et al.*, 1997; Sekimoto *et al.*, 1997 and Vidigal *et al.*, 1997). This result suggests that the yield quantity and quality of lettuce crops are possibly enhanced using a compound fertilizer of 18 % N, 7 % P and 16 % K at the rate of 150 gm m<sup>2</sup> under the conditions of the Al-Hassa oasis.

**Table (1): Effect of NPK fertilizer (18:7:16) on the vegetative and yield parameters of lettuce plants.**

Fertilizer treatments	Fresh weight	Dry/fresh weight	Leaf area	Total yield	Head diameter	Head circumference
gm/m <sup>2</sup>	gm/plant	%	m <sup>2</sup>	kg/m <sup>2</sup>	cm	cm
0	280.00	9.33	0.32	2.07	11.67	19.00
75	476.67	12.67	0.43	3.00	14.67	25.67
150	563.33	13.33	0.48	3.45	18.34	27.67
LSD 5%	44.22	1.22	0.02	0.23	1.22	4.49

Key: data presented are average of two seasons (1998/1999 and 1999/2000).

The results of the N, P and K contents (%) in the lettuce plant and the soil after harvest are summarized in Table (2). The data showed that N and K contents of the plants and the soil significantly increased after the fertilization with 150 gm m<sup>-2</sup> of NPK. In a comparison between all treatments, the P (%) content in the soil slightly increased, yet increases were not significant. Also, the P (%) content in the leaves did not show any variation between the treatments. This suggests that the applied rate of P was not adequately sufficient for growing crop providing that the initial value of available P was low in the experimental site (Thomas and Peaslee, 1973 and Rowell, 1994).

**Table (2):Effect of NPK fertilizer (18:7:16) on the NPK contents in the lettuce plants and the soil.**

Treatments (gm/m <sup>2</sup> )	Lettuce plants contents(%)			Soil contents (%)		
	N	P	K	N	P	K
0	1.783	0.003	3.617	0.003	0.0001	0.100
75	1.867	0.002	3.873	0.004	0.0002	0.103
150	1.890	0.003	4.387	0.006	0.0003	0.109
LSD 5%	0.004	NS	0.102	0.0005	NS	0.005

**Key: data presented are average of two seasons (1998/1999 and 1999/2000).**

Different investigators also reported similar results of the increase in NPK contents of the lettuce plants and the soil as a result of the NPK fertilizations (Sanchez *et al.*, 1990; Arshavskaya *et al.*, 1992; Hernandez *et al.*, 1992; Belligno *et al.*, 1997; Chen *et al.*, 1997 and Santos *et al.*, 1997). As shown by the leaf tissue analysis, Sanchez *et al.* (1990) for instance reported that P was the most important limiting nutrient as its levels in the tissue increased from 0.23 - 0.25 % with 25 % of the recommended pre-sowing NPK fertilizer rate to 0.30 - 0.36 % with the full recommended rate. Santos *et al.* (1997) suggested that the substrate concentrations of K, Na, Zn, Cu, and Mn varied significantly after harvesting lettuce plants.

This suggests that the lettuce cultivars varied in their nutrient uptake, indicating the importance of the NPK fertilization. It also shows the need for considering the initial soil contents of NPK to make a precise recommendation for best fertilization program appropriate for the soils of Al-Hassa area. Such program needs further and extensive works.

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تأثير معدلات مختلفة من السماد المركب على النمو الخضري والمحصول الكلى  
وجودة الرأس فى الخس  
عبد الرحمن بن محمد المدينى  
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العربية السعودية

تم تسميد نبات الخس بمعدلات مختلفة (صفر ، ٧٥ و ١٥٠ جرام للمتر المربع) من السماد المركب الذى يتكون من ١٨ % نيتروجين + ٧ % فوسفور + ١٦ % بوتاسيوم بهدف دراسة تأثيره على كل من النمو والمحصول وجودة الرأس ومحتواها من النيتروجين والفوسفور والبوتاسيوم وذلك خلال عامى ١٩٩٨/١٩٩٩ و ١٩٩٩/٢٠٠٠ .  
وقد أشارت النتائج إلى التالى:

- ١- توجد فروق معنوية بين المعاملات المسمدة والشاهد (الكنترول) فى كل من الوزن الجاف ، الوزن الطازج للنبات ، نسبة المادة الجافة إلى المادة الطازجة ، المساحة الورقية ، المحصول الكلى ، قطر الرأس و محيط الرأس فى كلا الموسمين.
- ٢- تم تحليل النبات وعينات التربة كيميائيا بعد حصاد المحصول لمعرفة محتواها من النيتروجين والفوسفور والبوتاسيوم ، حيث أوضحت النتائج أنه توجد فروق معنوية فى محتوى أوراق النبات والتربة التى أضيف لها السماد المركب والشاهد فى كل من النيتروجين والبوتاسيوم بينما الفوسفور أعطى زيادة غير معنوية فى كل من النبات والتربة بعد التسميد.