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INFLUENCE OF DIFFERENT LEVELS OF A COMPOUND FERTILIZER ON CABBAGE PLANT

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ABSTRACT

A field experiment aiming to study the effects of compound mineral fertilizer on the growth, yield and yield quality of cabbage plants was conducted during two successive seasons (1998/1999 and 1999/2000). The NPK fertilizer of 18:18:6 was applied to the cabbage plants at three rates (0, 150 and 300 gm per plant). The results showed that the application of NPK fertilizer at 300 gm per plant rate was in favor for producing the best weight per plant, number and leaf area of outer leaves, percentage dry / fresh matter, total yield, head circumference and head diameter. Stem length however was not affected significantly by the different NPK fertilization. Significant differences were also observed in the NPK contents in cabbage leaves and in the soil with an exception for the P %, which showed no significant differences between the fertilization treatments.

INTRODUCTION

Cabbage plant is commonly grown in King of Saudi Arabia (KSA) during autumn and winter seasons. It is one of the most popular leafy vegetables in the Kingdom. The soils in the Al-Hassa oasis of the KSA are characterized by their common nitrogen (N) and phosphorus (P) deficiency (Al-Taher, 1999). Cabbage plants are known for their high requirements of nutrients in particular the N, P and K to produce large heads and good leaves. In this regard, extensive works have been carried out abroad. In the present review, some of these studies especially the avaiblable recent ones are given.

The NPK fertilizer are essential elements for the developments of the cabbage plants. Borkowski and Beresniewicz (1991) indicated that the yields of cabbage crops were appreciably higher from plants fertilized with the mineral NPK fertilizers than fertilized with organic materials alone. Vendilo and Voitenko (1991) suggested that different applications of NPK fertilizers, with and without manure, showed different effects on the quality (sugars, vitamins, dry matter, nitrate) of the white cabbage plants grown from 1988 to 1990. Cerne (1991) found a 17 % increase in the yield of cabbage plants with the application of 30 t FYM / ha and NPK fertilizer (200 kg N + 90 kg P_2O_5 + 480 kg K_2O/ha) as compared with the NPK fertilization alone with only 240 kg K_2O/ha.

Also, the application of the NPK fertilizers causes differences in the quality of cabbage plants. Chen Yang *et al.* (1996) indicated that significant differences between the NPK fertilizer treatments (control, 20:20:20 and 31:10:10) were found for plant height, number of leaves, leaf area, shoot fresh weight, leaf length and leaf width. The best results were obtained with the 31:10:10 NPK fertilizer. Zhang (1990) presented a model to optimize the NPK rates on the basis of non-linear multiple regression functions.

Quantitative relationships between nutrient application and yield or content of quality-determining substances were described in the model. Kropisz (1992) reported that a high average yield (50.2 t/ha) for cabbage was obtained on plots receiving FYM plus NPK fertilizer. This fertilization strategy also affected the crop contents of NO_3-N, P, K, Mg, Fe, Mn, Zn and Cu. Higher yield (117.2 t/ha) was also obtained using 100:125:25 NPK fertilizers applied at sowing in a field trial (Jothi *et al*., 1993). The application of organic or mineral NPK fertilizers causes an increase in the soil NO_3-N level and a favourable P regime for the cabbage nutrition, leading to an improve in its yield (Kolota *et al*., 1992 and Stolyarov *et al*., 1993).

The current study aims to evaluate the influence of compound fertilizer (NPK) on the vegetative growth, leafy yield and quality of cabbage plants. NPK contents of cabbage leaves and the soil under the climatic conditions of the Al-Hassa region, KSA were also studied.

MATERIALS AND METHODS

A field experiment was carried out during 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. The experiment was done in an open field characterized by its sandy soil texture (96 % sand, 4 % silt and clay), low salinity ($EC_{1:2.5}$ = 1.6 dS m^{-1}), slightly alkaline ($pH_{1:2.5}$ = 7.8) and relatively low $CaCO_3$ content 7%. The soil of the field also contained low total nitrogen and available phosphorus content (0.002 % $\pm$ 0.0005 and 5 mg 1^{-1}, respectively). These parameters and other soil analysis were determined following the methods outlined by Rowell (1994).

In the current experiment, two levels of the NPK compound fertilizer (18 : 18 : 6) were included. The levels were 150 and 300 gm per plant. A control treatment (i.e., without fertilizer) was also included, giving a total of three fertilization treatments. The N used in the NPK fertilizer consisted of 2.69 % NH_4-N, 7.33 % NO_3-N and 5.98 % uric-N. In the meantime, the P and K were in the forms P_2O_5 and K_2O, respectively. The experiment design was a complete randomized block with four replicates. The total area of each plot was 19.2 m^2, being divided into 4 rows with 6 m length and 80 cm width each. The spacing between the plants was 50 cm. 50 days cabbage seedlings of the Branzoiek cultivar were used. They were transplanted on the 4th and 8th of November 1998 and 1999, respectively. All plots were irrigated by surface irrigation method. EC value of the irrigation water was 2.1 dS m^{-1} and a sodium adsorption ratio (SAR) of 4.65. Other recommended cultural practices of the Ministry of Agriculture and Water were also followed.

After harvesting, some measurements on the cabbage plants were done to determine the effects of the fertilizer treatments on their vegetative growth, total yield and head quality. The measurments were completed on a representative sample of 5 plants randomly selected from each plot. They include fresh weight per plant, dry / fresh weight ratio (%), leaf area of outer leaves (m^2), stem length (cm), number of outer leaves per plant, head diameter (cm), head circumference (cm) and total yield per squared meter. The N, P and K contents of the plants were also determined following the

methods described by Page *et al.* (1982). The data obtained were subjected to the proper statistical analysis (Gomez and Gomez, 1983).

RESULTS AND DISCUSSION

Vegetative parameters:

The results of the vegetative and yield parameters are presented in Table (1). The data show that the application of the compound mineral fertilizer (18 : 18 : 6) significantly increased the fresh weight per plant, number and leaf area of leaves, percentage dry / fresh weight ratio, total yield, head diameter and head circumference of the growing cabbage plants. Stem length however was not significantly affected by the fertilization treatments, through a general increasing trend was observed as the application rates of the fertilizer increased.

The highest values of these parameters were obtained with the fertilization treatment of 300 gm NPK per plant. Similar results were obtained by Borkowski and Beresniewicz (1991), who found that the best yield of cabbage was observed for the plants fertilized with mineral N from NPK fertilizer as 1.6 gm NH_4NO_3, 2 gm triple superphosphate and 1 gm K_2O_5. Also, Jothi *et al*. (1993) reported that the highest cabbage yield was achieved in a field trial in Tamil Nadu with the application of NPK fertilizer at 100, 125 and 25 kg/ha, respectively. Kolota *et al*. (1992) found that cabbage yield was high on plots receiving mineral NPK fertilizer UNO (a compound fertilizer containing macro and micro nutrients), which was as effective as the combination of the FYM + mineral fertilizers for two years. In several manners, other investigators reported analogous results (Zhang, 1990; Cerne, 1991; Vendilo and Voitenko, 1991; Kropisz, 1992 and Chen Yang, 1996). From the current study, it may be concluded that the yield quantity and quality of cabbage plants grown in the Al-Hassa oasis are possible to be improved by the application of mixed fertilizer of 18 % N, 18 % P and 6 % K at the rate of 300 gm/plant.

Table (1): The effects of the NPK fertilizer (18:18:6) on the vegetative and yield parameters of cabbage plants.

Fertilizer rats	Fresh weight	Stem length	No. of outer leaves	Leaf area of outer leaves	Dry/fresh weight	Total yield	Head dia.	Head circ.
gm/plant	kg/plant	cm		m^2	%	kg/m^2	cm	cm
0	2.77	18.73	9.50	0.94	10.80	1.61	47.67	15.00
150	4.77	19.08	13.17	1.09	14.63	3.22	62.00	25.00
300	5.20	19.27	15.44	1.28	16.33	3.83	63.67	32.67
LSD 5%	0.22	NS	0.60	0.12	0.57	0.53	1.22	6.37

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

Table (2) includes the data of the NPK contents in the cabbage plants and the soil after harvest. The results showed that both N % and K % in the cabbage plants and the soil were significantly increased with the application of compound NPK fertilizer (18:18:6). In contrast, the P % was not significantly affected by the different fertilization treatments included in the experiment.

However, a general increasing trend in P % was observed in both the plants and soil corresponding to the increased NPK fertilization. These results reported here agree with the findings of other researchers (Borkowski and Beresniewicz, 1991; Kolota *et al*., 1992; Kropisz *et al.,* 1992 and Stolyarov *et al*., 1993), who observed an increase in the NPK contents of the cabbage plants and the soil resulting from the increasing NPK fertilization.

Table (2): The effects of the NPK fertilizer (18:18:6) on the NPK contents in the cabbage plants and the soil.

Fertilizer rates	Cabbage plants contents(%)			Soil contents (%)		
(gm/m^2)	N	P	K	N	P	K
0	1.503	0.003	2.193	0.004	0.0002	0.104
150	1.514	0.004	2.830	0.006	0.0003	0.110
300	1.990	0.004	2.937	0.007	0.004	0.112
LSD 5%	0.16	NS	0.101	0.0002	NS	0.004

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

This shows that the cabbage plants take in their nutrients differently, suggesting the need for appropriate considerations for their requirements when fertilized with the NPK. Also, the analysis of the soil NPK contents is a useful guide to be taken into account when deciding the fertilization program for the cabbage crops in the Al-Hassa oasis. The soil test technique was also emphasized by others (Simpson, 1991 and Black, 1993).

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تأثير مستويات مختلفة من سماد مركب على نبات الكرنب

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تهدف هذه التجربة إلى دراسة تأثير معدلات مختلفة (صفر ، ١٥٠ و ٣٠٠ جرام للنبات) من السماد المركب (١٨ % نيتروجين + ١٨ % فوسفور + ٦ % بوتاسيوم) على كل من النمو والمحصول وجودته فى نباتات الكرنب خلال موسمين متتاليين (١٩٩٨/١٩٩٩ و ١٩٩٩/٢٠٠٠).

وقد أشارت النتائج إلى التالى:

١- أعطى التسميد المركب بمعدل ٣٠٠ جرام للنبات أفضل نتائج بالنسبة للوزن الطازج للنبات ، عدد الأوراق والمساحة الورقية للأوراق الخارجية ، نسبة المادة الجافة إلى المادة الطازجة ، المحصول الكلى للكرنب ، محيط الرأس وقطر الرأس ، بينما لم تظهر فروق معنوية بين النباتات المسمدة وغير المسمدة بالنسبة لطول الساق.

٢- أشارت النتائج إلى أنه توجد فروق معنوية بين النباتات المسمدة وغير المسمدة بالنسبة لمحتوى النبات والتربة من النيتروجين والبوتاسيوم ، بينما لم تظهر فروق معنوية خاصة بالفوسفور فى كل من النبات والتربة ، وبالرغم من ذلك نجد أن معاملة التسميد بمعدل ٣٠٠ جرام للنبات قد أعطت أعلى تركيز فى النبات والتربة لكل من النيتروجين والفوسفور والبوتاسيوم.