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Role of sowing date and fertilizers of mineral and organic on qualitative of kohlrabi (*Brassica oleracea* var. gongylodes)

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ABSTRACT

The current research aimed to know the effect of sowing date and fertilizers rate of mineral and organic on qualitative of kohlrabi. This study conducted on Kohlrabi (*Brassica oleracea* var. gongylodes) cv. White Vienna at the Experimental Station of the Department of Horticulture and Landscape, College of Agriculture, Tikrit University, during the winter season of 2021-2022. The experiment carried out according to Randomized Complete Block Design (RCBD) with three replications. The experiment consisted of two factors. First factor included three dates of sowning viz, 2/8, 16/8. and 1/9. Second factor included five levels of nitrogen combination i.e. (100% mineral (N), 75% mineral (N) + 25% organic (N), 50% mineral (N) + 50% organic (N), 25% mineral (N) + 75% organic (N) and 100% organic (N). The results showed that sowing date 2/8 recorded highest values in percentage nitrogen and potassium in kohlrabi leaves and percentage of acidity in knob. While, sowing dates 16/8 and 1/9 recorded highest values in total dissolved solids (TSS) in knob and content of vitamin C in knob respectively. On the other hand, using 25% (N) mineral+ 75% (N) organic improved all studied of quality characteristics except percentage of acidity in knob compared to other fertilizer treatments. Therefore, the interaction treatment between sowing date 2/8 with 25% (N) mineral+ 75% (N) organic increased percentage of nitrogen, phosphorous and potassium in the leaves, acidity and content of vitamin C in the knob.

دور موعد الزراعة و الأسمدة المعدنية والعضوية في الصفات النوعية لنبات الكلم (*Brassica oleracea* var. gongylodes)

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الخلاصة

يهدف البحث إلى معرفة تأثير موعد الزراعة و الأسمدة المعدنية والعضوية في الصفات النوعية لنبات الكلم. إذ أجريت هذه الدراسة على نبات الكلم (*Brassica oleracea* var. gongylodes) صنف White Vienna في المحطة الابحاث التابعة لقسم البستنة و هندسة الحدائق ، كلية الزراعة ، جامعة تكريت، خلال فصل الشتاء 2021-2022. نفذت التجربة حسب تصميم القطاعات العشوائية الكاملة (RCBD) وبثلاثة مكررات. تضمنت التجربة عاملين، العامل الاول ثلاثة مواعيد للزراعة و هي 8/2 و 8/16 و 1/ 9، فيما تضمن الموعد الثاني خمس توليفات من الاسمدة المعدنية و العضوية على اساس نسبة النيتروجين و هي 100% (N) معدني و 75% (N) معدني + 25% (N) عضوي و 50% (N) معدني + 50% (N) عضوي و 25% (N) معدني + 75% (N) عضوي و 100% (N) عضوي. أظهرت النتائج أن موعد الزراعة 8/2 سجل أعلى القيم في النسبة المئوية للنيتروجين والبوتاسيوم في أوراق الكلم ونسبة الحموضة في السيقان المتضخمة. بينما سجل موعدي الزراعة 8/16 و 9/1 أعلى القيم في المواد الصلبة الذائبة الكلية(TSS) ومحتوى فيتامين C في السيقان المتضخمة على التوالي. من ناحية أخرى ، أدى استخدام 25٪ (N) معدن + 75٪ (N) عضوي إلى تحسين جميع خصائص الجودة المدروسة باستثناء نسبة الحموضة في السيقان المتضخمة مقارنة بمعاملات الأسمدة الأخرى. لذلك فإن التفاعل بين موعد الزراعة 8/2 مع 25٪ (N) معدن + 75٪ (N) عضوي أدى إلى زيادة نسبة النيتروجين والفوسفور والبوتاسيوم في الأوراق والحموضة ومحتوى فيتامين C في السيقان المتضخمة.

الكلمات المفتاحية: نبات الكلم، موعد الزراعة، الاسمدة العضوية و المعدنية، الكربوهيدرات، فيتامين C ، السيقان المتضخمة

INTRODUCTION

Kohlrabi (*Brassica oleracea* var. gongylodes) is an important crop in Europe and America because of its short season, and it belongs to the cruciferous family. The swollen stem is the part that is edible and is called the knob. The kohlrabi plant is similar to turnip plant, but the part that is edible in the turnip is the swollen roots. Kohlrabi contains a high nutritional value of vitamin C, potassium and antioxidants (Shams, 2012).

The qualitative characteristics like vitamin C in vegetable crops are very important for human health. This helps in the absorption of iron, as well as tissue remedy, and strengthens the immune system (Camarena and Wang, 2016). There are millions of people suffering from vitamin C deficiency, especially in America. Therefore they are exposed to many diseases, including cancer (Nutr-facts.org, 2016). Nowadays, due to the increase in food culture in humans, it was necessary to think about increasing and enhancing the nutritional value of the kohlrabi plant and helping to obtain a healthy crop. Several studies have been conducted around the world on the effect of sowing time and fertilizers (mineral or organic) on the characteristics of vegetative growth and yield. (Ahmed *et al*., 2003; Shams, 2012; Jamil, 2017).

Howevere, there are almost no studies on the effect of sowing time and mineral or organic fertilizers on the quality characteristics of kohlrabi. Therefore, the idea of this study was about influence of sowing date and fertilizer levels of mineral and organic on qualitative of kohlrabi.

MATERIALS AND METHODS

This study was conducted at the Horticultural Research Station at the Department of Horticulture and Landscape/College of Agriculture/Tikrit University during August 2021 to January 2022. The experiment soil was sandy loam in texture. Data of chemical composition of compost manure and experimental farm soil physical and chemical properties were given in Tables 1 and 2. The Kohlrabi variety used for this study was White Vienna. The experiment consisted of 3 dates of sowning (2 August, 16 August and 1 September) and 5 combination levels of nitrogen (100% mineral (N), 75% mineral (N) + 25% organic (N), 50% mineral (N) + 50% organic (N), 25% mineral (N) + 75% organic (N) and 100% organic (N). The factorial experiment comprised 15 treatments. The experiment was laid out according to Randomized Complete Block Design with three replications. The total number of plots was 45. All amounts of compost, phosphorus and potassium were applied before transplanting in the form of superphosphate (21% P) and potassium sulfate (43% K). While nitrogen was divided into two equal portions, and applied before tranplanting and 8 weeks after transplanting, in the form of urea (46% N). The temperature and humidity of the research field are summarized in Table 3.

The studided parameters were percentage of nitrogen, phosphorous and potassium in the leaves (%), acidity in the knob (mg L^{-1}), content of vitamin C in knob (mg L^{-1}) and total dissolved solids (TSS) in knob. All parameters were recorded during after harvest.

Table 1: Chemical analysis of compost

pH	O.C (%)	O.M (%)	K (%)	N (%)	P (%)	C:N ratio	Na (%)	Ca (%)
5.4	27	79	0.2361	2.9	0.9	6.75	0.1123	0.1036

Table 2: Physical and chemical analyses of the experimental soil

Soil Texture				pH	EC	CEC	OM	Lime	Gypsum	N	P	K
Sand (g kg^{-1}) soil	Silt (g kg^{-1})	153 (g kg^{-1})	Texture		(ds m^{-1})	(cmol kg^{-1} soil)		(g kg^{-1} soil)	(g kg^{-1} soil)	(g kg^{-1} soil)	(g kg^{-1} soil)	(g kg^{-1} soil)
511	330	139	Sandy loam	7.5	2.78	18.5	1.07	168	154.20	39.06	4.60	122.63

Table 3. Mean values of weather parameters recorded during study season

Month	Max. Temp. (°C)	Min. Temp. (°C)	Average Temp. (°C)	Max. RH (%)	Min. RH (%)
August	44.53	28.69	36.61	25.65	9.21
September	39.44	23.36	31.39	32.52	10.08
October	34.93	17.44	24.94	43.36	13.87
November	25.86	12.37	18.86	60.92	21.21
December	18.92	6.60	12.43	86.91	40.50
January	15.93	2.30	8.90	95.30	41.25

The collected data were analyzed using analysis of variance (ANOVA) by the SAS software package (version 9.0). The comparison of means was performed by Duncan at a P≤ 0.05 probability level.

RESULTS AND DISCUSSION

The results on the effect of different sowing date and fertilizer treatments on the percentage of nitrogen in kohlrabi leaves are presented in Table 4. Significant (P≤0.05) differences were observed in the percentage of nitrogen in the kohlrabi leaves between the treatments.

Table 4. Effect of sowing date and fertilizers rate of mineral and organic and interaction between them on percentage of nitrogen in the leaves (%)

Treatment	100% (N) mineral	75% (N) mineral+ 25% (N) organic	50% (N) mineral+ 50% (N) organic	25% (N) mineral+ 75% (N) organic	100% (N) organic	Mean
2/8	2.558 b	2.401 bc	2.335 bcd	3.664 a	2.368 bcd	2.665 a
16/8	2.343 bcd	1.887 cde	1.845 de	3.748 a	1.851 de	2.335 b
1/9	2.224 bcde	2.303 bcd	2.090 bcd	3.617 a	1.747 e	2.396 b
Mean	2.375 b	2.197 bc	2.090 c	3.676 a	1.989 c	

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05)

Sowing date 2/8 recorded highest value 2.665%, while sowing date 16/8 recorded lowest value 2.335%, but there was no significant difference with sowing date 1/9. On the other hand, treatment of fertilizer 25% mineral (N) + 75% organic (N) increased significantly in this characteristic, whereas treatment of fertilizer 100% organic (N) reduced significantly. At the same time, the interaction treatment between three dates of planting 2/8, 16/8 and 1/9 with treatment of fertilizer 25% mineral (N) + 75% organic (N) had largest values 3.664, 3.748 and 3.617% respectively, in contrast the interaction treatment between sowing date 1/9 with treatment of fertilizer 100% organic (N) had smallest value 1.747%.

Table 5. Refers that there was no significant differences between sowing dates in the content of phosphorous in the kohlrabi leaves. Meanwhile, the highest the content of phosphorous in the kohlrabi leaves was observed in fertilizer 25% mineral (N) + 75% organic (N). But, the lowest the content of phosphorous in the kohlrabi leaves was observed in mineral fertilizer was applied alone as compared to all other fertilizer treatments. In regards the interacting treatments, sowing date 2/8 with fertilizer 25% mineral (N) + 75% organic (N) showed significant increment. In contrast, using mineral fertilizer alone 100% mineral (N) decreased significantly 0.2301ppm.

Table 5. Effect of sowing date and fertilizers rate of mineral and organic and interaction between them on of phosphorous in the leaves (ppm)

Treatment	**100% (N) mineral**	**75% (N) mineral+ 25% (N) organic**	**50% (N) mineral+ 50% (N) organic**	**25% (N) mineral+ 75% (N) organic**	**100% (N) organic**	**Mean**
2/8	0.2336 c	0.4268 abc	0.4158 abc	0.5389 a	0.4546 abc	0.4139 a
16/8	0.2301 c	0.2986 bc	0.5115 ab	0.4818 ab	0.4377 abc	0.3919 a
1/9	0.3125 abc	0.3605 abc	0.3506 abc	0.4992 ab	0.4719 ab	0.3989 a
Mean	0.2587 c	0.3620 bc	0.4260 ab	0.5066 a	0.4547 ab	

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05)

The sowing date 2/8 produced the highest percentage of potassium in the kohlrabi leaves, followed by 16/8, while the lowest percentage of potassium in the kohlrabi leaves from sowing date 1/9 (Table 6). The highest percentage of potassium in the kohlrabi leaves was obtained from the treatment of fertilizer 25% mineral (N) + 75% organic (N) compared to the other treatments of fertilizers. On regard interaction treatments higher percentage of potassium in the leaves obtained was sowing date 2/8 with fertilizer 25% mineral (N) + 75% organic (N) compared to other interaction treatments, whereas lower percentage of potassium in the leaves obtained was sowing date 1/9 with fertilizer 100% mineral (N).

Table 6. Effect of sowing date and fertilizers rate of mineral and organic and interaction between them on percentage of potassium in the leaves (%)

Treatment	**100% (N) mineral**	**75% (N) mineral+ 25% (N) organic**	**50% (N) mineral+ 50% (N) organic**	**25% (N) mineral+ 75% (N) organic**	**100% (N) organic**	**Mean**
2/8	1.994 efgh	2.298 dfgh	2.996 cd	4.367 a	3.078 bcd	2.947 a
16/8	2.591 cdefg	1.922 fgh	2.808 cdef	3.464 bc	2.810 cdef	2.719 ab
1/9	1.345 h	1.710 gh	2.881 cde	3.892 ab	2.940 cd	2.554 b
Mean	1.977 c	1.977 c	2.895 b	3.908 a	2.943 b	

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05)

The sowing date 2/8 showed improved percentage of acidity in the knob compared to sowing date 16/8 (Table 7). Whereas, the fertilizer treatments didn't affect on the percentage of acidity in the knob. On the other hand, the combined treatment of sowing date 2/8 and fertilizers 25% mineral (N) + 75% organic (N) provided the highest acidity in the knob 0.5973 %, and the lowest value 0.2987 % in the sowing date 16/8 with fertilizer 100% organic (N).

Table 7. Effect of sowing date and fertilizers rate of mineral and organic and interaction between them on acidity in the knob (%)

Treatment	100% (N) mineral	75% (N) mineral+ 25% (N) organic	50% (N) mineral+ 50% (N) organic	25% (N) mineral+ 75% (N) organic	100% (N) organic	Mean
2/8	0.4693 ab	0.5547 ab	0.4693 ab	0.5973 a	0.4693 ab	0.5120 a
16/8	0.5120 ab	0.4267 ab	0.4267 ab	0.3413 ab	0.2987 b	0.4011 b
1/9	0.5120 ab	0.4267 ab	0.2987 b	0.3840 ab	0.4693 ab	0.4181 ab
Mean	0.4978 a	0.4694 a	0.3982 a	0.4409 a	0.4124 a	

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05)

The effect of different time of planting on content of vitamin C in knob during is presented in Table (8). The obtained data showed that, the sowing date 1/9 ranked the first in increasing content of vitamin C in knob, followed by the sowing date 2/8 and lastly coming sowing date 16/8.

Table 8. Effect of sowing date and fertilizers rate of mineral and organic and interaction between them on content of vitamin C in knob (mg $100ml^{-1}$)

Treatment	100% (N) mineral	75% (N) mineral+ 25% (N) organic	50% (N) mineral+ 50% (N) organic	25% (N) mineral+ 75% (N) organic	100% (N) organic	Mean
2/8	0.2453 c	0.3073 bc	0.3440 bc	0.5573 a	0.3185 bc	0.3545 ab
16/8	0.2453 c	0.2933 c	0.2640 c	0.3520 bc	0.3520 bc	0.3013 b
1/9	0.3226 bc	0.2933 c	0.4400 ab	0.5573 a	0.2933 c	0.3813 a
Mean	0.2711 b	0.2980 b	0.3493 b	0.4889 a	0.3213 b	

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05)

Meanwhile, there was significant variation obtained within the fertilizer treatments. The addition of fertilizer 25% mineral (N) + 75% organic (N) showed significant increment in content of vitamin C in knob compared with other fertilizer treatments. On regard, the interaction treatments the same table shows that sowing date s 2/8 and 1/9 with fertilizer treatment 25%

mineral (N) + 75% organic (N) had the largest value of content of vitamin C in knob 0.5573 mg $100ml^{-1}$ to each them. While, sowing date s 2/8 and 16/8 with fertilizer treatment 100% mineral (N) had the smallest value 0.2453 mg $100ml^{-1}$ to each them.

Total dissolved solids in the knobs were widely affected by sowing dates (Table 9). The highest values of total dissolved solids in the knobs were at sowing dates 16/8 and 1/9 which were 5.80 and 5.62% respectively. While, the highest value of total dissolved solids in the knobs was at sowing date 2/8 which was 496%.

Table 9. Effect of sowing date and fertilizers rate of mineral and organic and interaction between them on total dissolved solids (TSS) in knob (%)

Treatment	100% (N) mineral	75% (N) mineral+ 25% (N) organic	50% (N) mineral+ 50% (N) organic	25% (N) mineral+ 75% (N) organic	100% (N) organic	Mean
2/8	3.90 g	4.14 fg	5.61 cd	6.43 b	4.70 ef	4.96 b
16/8	4.30 fg	5.56 cd	6.33 b	7.40 a	5.42 de	5.80 a
1/9	3.65 g	4.76 ef	6.53 b	7.60 a	5.56 cd	5.62 a
Mean	3.95 d	4.82 c	6.16 b	7.14 a	5.23 c	

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test ($P \leq 0.05$)

Knobs at fertilizer treatment 25% mineral (N) + 75% organic (N) recorded the highest value of total dissolved solids 7.14%. In contrast, using mineral fertilizer alone recorded the lowest value of total dissolved solids 3.95%. On the other hand, sowing dates 16/8 and 1/9 with fertilizer treatment 25% mineral (N) + 75% organic (N) increased significantly in total dissolved solids (TSS) in knob 7.60 and 7.40% respectively. But, sowing dates 2/8 and 1/9 with fertilizer treatment 100% mineral (N) reduced significantly 3.90 and 3.65% respectively.

From the results of this study, it was found that the sowing date 2/8 gave a significant increase in the percentage of nitrogen and potassium in the leaves and acidity in the knob (Table 4, 6 and 7). This difference in the effect of sowing date may be attributed to the influence on environmental conditions, especially the temperature to which the plant was exposed. This influence led to the appropriate conditions in the create of a strong vegetative growth, which was positively reflected on the root system in the absorption of water and nutrients and their transfer to the leaves. This plays an important role in the synthesis of DNA and RNA that interfere in the process of photosynthesis, activation of enzymes and the synthesis of chlorophyll compounds. Thus, it led to accumulation of manufactured substances and increase their transmission and concentration in the knob (Delvin, 1975). Also, Tables 8 and 9 showed a significant increase in the percentage of vitamin C and total dissolved solids (TSS) in knob at

sowing date 1/9. This was due to the increase in the accumulation of manufactured materials in the stem and its increase in hypertrophy. Consequently, this increased stem content of soluble solids and vitamin C.

It was clear from the results of Tables 4, 5, 6, 8 and 9 that there was a significant difference in some qualitative characteristics of the kohlrabi plant when application of fertilizer 25% mineral (N) + 75% organic (N). The reason for this was that the chemical and organic fertilizers together were considered one of the integrated fertilizers that contain most of the elements needed by the plant in its vital activity, such as the main elements nitrogen, phosphorous and potassium (Table 1). Which enter into the formation of the compounds that participate in the formation of (RNA) DNA)), and of these compounds (UTP) that play an important role in the formation of glucose and sucrose, which have a role in the formation of the energy complex (ATP) that the plant needs to form organic compounds that benefit the plant to form a strong vegetative system. Which is positively reflected on the root system in absorbing elements and accumulating them in the leaves. Thus, the process of photosynthesis increases and the materials manufactured in the leaves are increased and moved to their storage place. It also increases the percentage of soluble solids in the plant and some vitamins, including vitamin (C), and helps in the ripening of the crop (Al-Nuaimi, 1999). These results agree with Saleh (2013).

CONCLUSION

The study showed that the sowing date improved qualatitive chracterstics of kohlrabi. The sowing date 2/8 promoted better in the percentage nitrogen and potassium in kohlrabi leaves and percentage of acidity in knob. while, sowing dates 16/8 and 1/9 recorded highest values in total dissolved solids (TSS) in knob and content of vitamin C in knob respectively. Also, combination fertilizer 25% mineral (N) + 75% organic (N), showed improvement in all the studied quality characteristics. In addition, the interaction treatment between sowing date 2/8 and (25) mineral (N) + 75% organic (N) increased percentage of nitrogen, phosphorous and potassium in the leaves, acidity and content of vitamin C in the knob.

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