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INVESTIGATIONS ON YIELD AND QUALITY OF KOHLRABI (*Brassica oleraceae* var. *gongylodes* L.) IN THE TRAKYA REGION of TURKEY

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Abstract: This research was carried out to determine the possibility of growing kohlrabi (*Brassica oleraceae* var. *gongylodes* L.) under Trakya (Turkey) conditions during the spring and fall growing periods in the year of 2000. In each period, three kohlrabi cultivars (Express Forcer, Neckar, Lahn), two seedling ages (four or six weeks old) and three planting dates (at two week intervals in April, May for spring and in September, October for fall), with respect to yield and quality characteristics, were evaluated. Cultivars Neckar and Express Forcer had higher yield and quality than Lahn in both seasons. Higher yield was obtained from six weeks old seedlings in the spring, while a period of four weeks was sufficient for growing seedlings in fall.

Key words : cultivars, kohlrabi, planting date, seedling age, yield

Trakya Bölgesi'nde Alabaş (*Brassica oleraceae* var. *gongylodes* L.) Verim ve Kalitesi Üzerine Araştırmalar

Özet: Bu araştırma 2000 yılı ilkbahar ve sonbahar döneminde Trakya koşullarında alabaş (*Brassica oleraceae* var. *gongylodes* L.) yetiştirme olanağını belirlemek amacıyla yürütülmüştür. Her bir periyotta üç alabaş çeşidi (Express Forcer, Neckar, Lahn), iki fide yaşı (dört ve altı haftalık) ve üç dikim zamanı (iki hafta aralıklarla ve ilkbaharda Nisan ve Mayısta, sonbaharda Eylül ve Ekimde) verim ve kalite özellikleri bakımından değerlendirilmiştir. Neckar ve Express Forcer çeşitleri her iki sezonda da Lahn'dan daha yüksek verim ve kalite vermiştir. Sonbaharda dört haftalık süre fide yetiştirme süresi yeterliyken, ilkbaharda altı haftalık fidelerden daha yüksek verim elde edilmiştir.

Anahtar kelimeler : alabaş, çeşit, dikim zamanı, fide yaşı, verim

Introduction

Turkey has 79 million hectares area with a wide variety at soil and climate. A large range of crops species including many horticultural crops are grown in approximately 36% of this land area. In Turkey, production of horticultural crops is around 29 million tons and approximately 70% of this production is vegetable crops. The country is among the top five vegetable producing countries in the world in term of production and area. Vegetable crops are commonly grown in Mediterranean (south), Aegean (west) and Marmara (northern-west) regions. Tomatoes, water melons, onions melons and cucumbers are the most commonly grown vegetable crops in Turkey. Cabbage, belonging to Cruciferae family, ranks among the top eight with a total production of approximately 577 000 tons. Vegetable crops also have a significant place in the agricultural exports of the country. For instance, Turkey exported 370 000 tons of fresh vegetables in 1999, which corresponds to 19 million US$. Export of fresh as well as processed vegetables, is a rapidly growing agro-industry sector in Turkey. Russian Federation, Germany, Saudi Arabia are the biggest importing countries of Turkish vegetables, although Turkish vegetal products (including vegetables) are exported to 50 countries, (Anonymous a, 2000; Anonymous b, 2000; Vural et al., 2000).

Trakya which is located in north-west of the country has a wide range of climates and soil conditions and therefore almost all vegetables can be grown. But, the greater part of agricultural land is being used to produce the field crops such as wheat and sunflower. The gross income value of vegetables is over 4.5%, while vegetables utilize 1.03% of the total agricultural area of the province.

The demand for vegetables is on the rise due to increasing population, changing food habits, realization of high the nutritional value of vegetable crops and

greater emphasis on value addition and export in Turkey as well as the entire world. Presently, growers are directed towards new crops instead of traditional crops such as wheat and sunflower due to changes in the last agricultural policy and structural adjustments in Turkey.

Kohlrabi (*Brassica oleraceae* var. *gongylodes* L.), belongs to the large and agriculturally important family Cruciferae is a fast growing cool season vegetable crop. It is grown primarily for its enlarged stem that is rich in nutritional components, especially with respect to vitamin C and potassium. The enlarged stem of the plant can be eaten raw, cooked or preserved, while its young leaves can be used for salads or cooked like spinach. It is widely grown in northern, central Europe and America (Splittstoesser, 1990; Krug, 1991; Liebster, 1991). According to vegetable production records, there is no kohlrabi production in Turkey, while other members of Cruciferae family such as cabbage, cauliflower, and radish are grown in almost all parts of the country (Vural et al., 2000). Kohlrabi can be an alternative crop for vegetable growers due to it's similarity to other Cruciferae members, having a short growing season and its export possibility. Unfortunately, a supply and demand study on kohlrabi in Turkey is not available for producers and researchers. The objective of this study was to investigate this possibility and prepare a background for future kohlrabi researches.

Materials and Methods

This study was planned to determine the possibility of growing kohlrabi (*Brassica oleraceae* var. *gongylodes* L.) in the Trakya region and was carried out at the experimental field at the Trakya University, Faculty of Agriculture (lat 40°59'N, long 27°29'E, alt 4 m asl), and Department of Horticulture in 2000. This area is classified as semi arid, with a cool, rainy season from November to April, and a hot, dry season from May to October. According to long term climatic data, the mean annual rainfall is about 580 mm, and means air temperatures vary from 4.5 (in January) to 23.3 °C (in July). The experiment was carried out for two seasons (spring and fall). Three cultivars [Express Forcer (Takii-Japan), Neckar and Lahn (Rick Zwaan-Netherlands)], three planting dates (at two weeks interval in April, May for spring and in September, October in fall) and two-seedling ages (four or six weeks old) were used to determine suitable cultivars, planting dates and seedling age for each season. The cultivars are F1 hybrid and white skinned varieties. Lahn and Neckar are recommended for summer and fall crops in north-west Europe. Express Forcer is early maturing and the most commonly cultivated in various region of the world. They are suitable for open-field production (Rijk Zwaan, 2000; Takii, 2000).

Seeds of all cultivars were sown at depth of 1 cm by hand into plug-trays filled with commercial peat-like mixes. The properties of growing medium are given in Table 1. The individual cells of plug-trays contained approximately 100-ml of mix.

Table 1. The properties of growing media.

N (mg/l)	P_2O_5 (mg/l)	K_2O (mg/l)	pH	EC (μs/cm)
100-300	100-300	150-400	5.4-5.9	350

Planting dates were determined by taking account of meteorological data and requirement of kohlrabi. The monthly air temperature, precipitation, relative humidity and soil temperature of the experimental area during the growing periods were presented in Table 2.

Table 2. The monthly air temperature, precipitation, relative humidity and soil temperature of the experimental area during the growing periods.

	Average temp. (°C)	Average max. temp. (° C)	Average min. temp. (°C)	Precipitation (mm)	Relative humidity (%)	Soil temp. (depth at 5 cm,°C)
April	14.0	19.7	11.0	48.5	84.8	17.1
May	16.6	21.8	12.0	67.0	77.2	20.8
June	20.9	24.8	15.9	11.8	72.2	25.9
July	25.4	28.3	19.3	0.0	68.7	30.5
August	24.4	28.8	19.6	18.1	71.7	28.3
September	20.3	24.8	13.8	20.6	77.1	24.1
October	14.9	18.7	10.9	82.2	81.3	17.0
November	12.7	16.1	9.9	9.2	85.9	14.0
December	8.7	15.8	5.7	10.1	80.2	8.9

Table 3. Main effects of cultivar and planting date on leaf number, leaf weight (g), leaf area (dm2), soluble solid content of tuber (SSC, %) for spring growing season.

	Leaf number	Leaf weight	Leaf area	Soluble solid content
Cultivars				
E. Forcer	12.2 a	79.9 a	10.7 ab	5.2 b
Neckar	11.4 b	85.7 a	13.1 a	5.1 b
Lahn	13.0 a	53.7 b	9.4 b	5.6 a
Planting dates				
04-03-00	12.5 a	61.4 b	9.2 b	5.1 b
04-17-00	13.5 a	86.0 a	12.5 a	5.4 a
05-01-00	10.6 b	71.9 ab	11.4 ab	5.5 a

Cultivars		Planting dates	
LSD 0.05 (Leaf number)	: 1.21	LSD 0.05(Leaf number)	: 1.20
LSD 0.05 (Leaf weight)	:17.81	LSD 0.05(Leaf weight)	: 17.81
LSD 0.05 (Leaf area)	: 2.64	LSD 0.05(Leaf area)	: 2.64
LSD 0.05 (Soluble solid cont)	: 0.31	LSD 0.05(Soluble solid cont)	: 0.31

Four or six weeks old seedlings of each cultivar were transplanted into a ground bed in the field in each planting date. Plants were spaced 0.30 m within the rows and 0.40 m between rows. Plots were cultivated and irrigated as needed. The field soil was a silty clay loam with a pH 7.4, with organic matter levels at 1.7%. Soil test results indicated that additional K2O was not required for kohlrabi production, but 120 kg N ha-1and 60 kg P2O5 ha-1 were applied to the soil. Compose (20-20-0) and ammonium nitrates (26-0-0) were used as fertilizer. Half of the N and the entire P2O5 utilized were incorporated prior to planting as a basal dressing and the remaining N was applied three weeks after planting. Benomyl was applied periodically as a fungicide while endosulfan and diazinon used as insecticides in the study.

The following parameters were measured or evaluated: number of leaf (bigger than 2 cm), leaf weight (g), tuber weight (g), tuber diameter (mm), tuber index (diameter/height ratio), tuber ratio [tuber weight/plant weight (%)], and yield [total plant weight per plot (kg)] were recorded for each treatment. Soluble solid content was determined by hand held refractometer. The leaf area was measured using scanner.

The experiment was established as a factorial randomized block design with three replications. Data were subjected to analysis of variance, with factorial comparisons of main effects and interactions. Means were tested by protected LSD (at the 0.05 level). MSTAT 3.51 was used for analysis of variance.

Results

The harvest dates ranged from 52 to 63 days after planting depending on cultivars and growing season. Only the main effects of cultivar and planting dates in the spring were significant for leaf properties (number, weight or area) (Table 3). Neckar had the lowest leaf number (11.4), but gave the highest value in term of leaf weight and area. The second planting date ranked first for average leaf number of 13.5, leaf weight of 86.0 g and leaf area of 12.5 dm2 . Differences among cultivars were important for the soluble solid content. The SSC of cv. Lahn, was 5.6 % higher than other cultivars. The soluble solid content of tubers was lower for the first planting date (3 April) compared to the last planting date, and was 5.1 and 5.5, respectively.

The main effects of cultivar and seedling age and their interaction had a significant effect on tuber weight, and the highest value was obtained from 6 week old seedlings of E. Forcer (815.0 g) and lowest from Lahn for both seedling ages (Table 4 and 5). The results regarding tuber diameter was similar to results for tuber weight. Among cultivars, Neckar and E. Forcer had larger tubers than Lahn (respectively 114.7 and 107.2 mm). Although there were no big differences between values obtained from planting date×seedling age interaction, the greatest value (109.7 mm) was obtained from 6 weeks-old seedlings of second planting time of Neckar and lowest value (99.7 mm) from 4 weeks-old seedlings of same planting time of Neckar. Tuber index was significantly affected by cultivar, planting date, seedling age and planting date×seedling age interaction. While the lowest tuber index (0.97) was found in Lahn, index of

Table 4. Main effects of cultivar, planting date and seedling age on tuber weight (g), tuber diameter (mm), tuber index (tuber diameter/tuber height) and yield (kg/plot) for spring growing season.

	Tuber weight	**Tuber diameter**	**Tuber index**	**Yield**
Cultivars				
E. Forcer	722.4 a	107.2 a	1.19 a	14.606 a
Neckar	762.0 a	114.7 a	1.11 ab	15.616 a
Lahn	495.6 b	94.8 b	0.97 b	9.787 b
Planting dates				
04-03-00	698.7	105.6	0.96 b	13.087
04-17-00	630.6	104.7	1.18 a	13.082
05-01-00	650.6	106.5	1.12 ab	13.840
Seedling age				
6 weeks	692.9 a	105.9	1.01 b	13.845
4 weeks	627.1 b	105.3	1.18 a	12.828

	Cultivars	*Planting dates*
LSD 0.01 (Tuber weight)	:105.21	
LSD 0.01 (Tuber diameter)	: 7.57	
LSD 0.01 (Tuber index)	: 0.17	0.17
LSD 0.01 (Yield)	: 2.30	

Table 5. Effect of cultivar×seedling age interaction on tuber weight (g), and planting date×seedling age interaction on tuber diameter (mm) and tuber index (tuber diameter/tuber height) for spring growing season.

Cultivar and seedling age	Tuber weight	**Planting date and** seedling age	Tuber diameter	Tuber index
E. Forcer 6 week	815.0 a	04-03-00 6 week	101.9 ab	0.77 b
4 week	629.8 b	4 week	109.2 a	1.17 a
Neckar 6 week	768.9 a	04-17-00 6 week	109.7 a	1.18 a
4 week	755.0 a	4 week	99.7 b	1.19 a
Lahn 6 week	494.8 c	05-01-00 6 week	106.1 ab	1.08 a
4 week	496.4 c	4 week	106.8 ab	1.18 a

cultivar×seedling age		planting date×seedling age	
LSD 0.05 (Tuber weight)	: 110.82	LSD 0.05 (Tuber diameter)	: 7.98
		LSD 0.05 (Tuber index)	: 0.18

Neckar and E. Forcer were greater than one. In planting date×seedling age interaction, all applications were placed at the same importance group, except for 6 weeks-old seedling which was planted on 3 April. As can be seen from Table 4, differences only among cultivars in point of yield were statistically important. Neckar gave the highest yield (15.616 kg). E. Forcer which was placed at the same group with Neckar ranked in the second position with an average yield of 14.606 kg. The lowest yield was obtained from Lahn (9.787 kg). There were no significant differences for tuber ratio (data not shown).

For the fall growing period, leaf number was affected by cultivar, planting date, and seedling age and cultivar × planting date interaction (Table 6, 8). Among cultivars, E. Forcer, among planting dates, first planting time, and between seedling ages, 6 weeks-old seedling had the highest number of leaf. In term of leaf weight, differences among cultivars, planting date, seedling age were significant. Cultivar×planting date interaction was also significant. Lahn planted on 4 September gave the lowest value with 56.6 g, while the heaviest leaves were obtained from Neckar which was planted on 18 September (average 98.0 g). Leaf weight of plants planted as 4 weeks-old seedlings was greater than other seedling ages. The results of leaf area were similar with those of leaf weight. Leaf area varied for cultivars ranged from 12.5 to 15.6 dm2 depending on cultivars and the highest value was obtained from Neckar. Among planting times, those planted on the 18th of September gave the highest leaf area (16.1 dm2).

Table 6. Main effects of cultivar, planting date and seedling age on leaves number, leaves weight (g), leaf area (dm2), soluble solid content of tuber (SSC, %) for fall growing season.

	Leaf number	Leaf weight	Leaf area	Soluble solid content
Cultivars				
E. Forcer	16.8 a	70.3 b	12.5 b	6.4 c
Neckar	14.0 b	84.9 a	15.6 a	7.3 b
Lahn	13.0 c	74.2 ab	13.8 ab	9.0 a
Planting dates				
09-04-00	17.0 a	63.7 b	11.4 b	7.4 b
09-18-00	14.5 b	87.4 a	16.1 a	8.2 a
10-02-00	13.2 c	78.3 a	14.3 ab	7.3 b
Seedling age				
6 week	15.4 a	68.6 b	12.6 b	7.3 b
4 week	13.4 b	84.2 a	15.2 a	7.8 a

Cultivars		Planting dates	
LSD 0.01 (Leaf number)	: 0.91	LSD 0.01 (Leaf number)	: 0.91
LSD 0.01 (Leaf weight)	:10.98	LSD 0.01 (Leaf weight)	:10.98
LSD 0.01 (Leaf area)	: 2.19	LSD 0.01 (Leaf area)	: 2.94
LSD 0.01 (Soluble solid cont)	: 0.69	LSD 0.01 (Soluble solid cont)	: 0.69

Table 7. Main effects of cultivar, planting date and seedling age on tuber weight (g), tuber diameter (mm), tuber index (tuber diameter/tuber height), tuber ratio (tuber weight/plant weight, %) and yield (kg/plot) for fall growing season.

	Tuber weight	Tuber diameter	Tuber index	Tuber ratio	Yield
Cultivars					
E. Forcer	280.8 a	80.6 a	1.10 c	78 a	6.631 a
Neckar	275.4 a	78.8 a	1.28 b	73 b	6.208 b
Lahn	105.0 b	60.4 b	1.39 a	58 c	3.374 b
Planting dates					
09-04-00	227.6	69.8 b	1.14 b	73 a	5.156
09-18-00	200.5	71.6 b	1.31 a	64 b	5.390
10-02-00	243.2	78.4 a	1.32 a	72 a	5.666
Seedling age					
6 weeks	225.5	72.3	1.21 b	71 a	5.294
4 weeks	225.4	74.3	1.31 a	68 b	5.515

	Cultivars	*Planting dates*
LSD 0.01 (Tuber weight)	:53.95	
LSD 0.01 (Tuber diameter)	: 7.63	5.396048
LSD 0.01 (Tuber index)	: 0.05	0.0463738
LSD 0.01 (Tuber ratio)	: 4.98	4.981345
LSD 0.01 (Yield)	: 1.13	

Significant differences were observed between cultivars, planting date and seedling age for soluble solids content. Lahn, second planting time and 4 week old seedling had highest value 9.0, 8.2 and 7.8% respectively (Table 6). A significant difference among cultivars was observed in tuber weight (Table 7). Average tuber weight of E. Forcer was 280.8 g, while Lahn had the lightest tubers (105.0 g). Tuber diameter was significantly affected by cultivar, planting date main effect and cultivar×seedling age interaction. Among planting dates, the third planting date gave the highest tuber diameter. Among cultivar×seedling age interaction (Table 9), tuber diameter was less for Lahn than other cultivar combinations. Based on the results of tuber index, all main effect and interactions were statistically important, except for planting date×seedling age (Table 7, 9). While the tuber index of E. Forcer planted on 4th of September was less than one, all of others had greater diameter than tuber height. Tuber index changed between 1.09 and 1.41 depending on cultivar×seedling age combination, and the highest values were obtained from Lahn in both seedling age and Neckar planted at 4 weeks old seedling period. Tuber ratio was significantly affected by main effects and cultivar×seedling age interaction. Among planting dates, the second planting time gave

Table 8. Effect of cultivar×planting date interaction on leaves number, leaves weight (g) and tuber index (tuber diameter/tuber height) for fall growing season.

Cultivar and planting date		Leaf number	Leaf weight	Tuber index
	09-04-00	19.6 a	59.1 d	0.82 b
E. Forcer	09-18-00	16.5 b	85.5 ab	1.28 a
	10-02-00	14.3 cd	66.0 cd	1.20 a
	09-04-00	15.4 bc	75.2 bc	1.23 a
Neckar	09-18-00	13.9 cde	98.0 a	1.28 a
	10-02-00	12.6 e	80.5 b	1.33 a
	09-04-00	13.4 d	56.6 d	1.37 a
Lahn	09-18-00	13.1 de	77.8 bc	1.37 a
	10-02-00	12.6 e	88.3 ab	1.43 a

LSD 0.01 (Leaves number) : 1.58 LSD 0.01 (Leaves weight) :14.17 LSD 0.01 (Tuber index) :0.25

Table 9. Effect of cultivar×seedling age interaction on tuber diameter (mm), tuber index (tuber diameter/tuber weight), tuber ratio (tuber weight/plant weight, %) and yield (kg/plot) for fall growing season.

Cultivar and seedling age		Tuber diameter	Tuber index	Tuber ratio	Yield
E. Forcer	6 week	78.8 a	1.09 b	79 a	6.317 a
	4 week	82.9 a	1.21 b	78 a	6.945 a
Neckar	6 week	81.8 a	1.17 b	79 a	6.928 a
	4 week	75.8 a	1.40a	67 b	5.488 ab
Lahn	6 week	56.7 b	1.37 a	57 c	2.637 c
	4 week	64.1 b	1.41 a	59 c	4.110 bc

LSD 0.01 (Tuber diameter) :7.63 LSD 0.05 (Tuber index) : 0.15
LSD 0.05 (Tuber ratio) :7.04 LSD 0.05 (Yield) : 1.60

the lowest tuber ratio with 64%, the other two planting times were not significantly different from one another. When yield is considered, it was observed that the differences between cultivar and cultivar×seedling age interaction were statistically important (Table 7, 9). The yield of E. Forcer and Neckar was higher than Lahn. The yield of Lahn was approximately one half of the other cultivars.

Discussion

Yield of kohlrabi is generally evaluated as the result of tuber size. During the spring growing season, tuber weight, diameter, and yield values were the greater than during the fall growing season. There is a high probability that this correlates with the higher temperature and light conditions of spring. Fink and Krug (1989) found that the growth rate of tuber diameter and leaf area at 18 °C were greater than those of 10 °C, and Wendt (1978) reported that increasing the soil temperature from 5 to 20 °C produced larger stems in cv. Roggli's Weisser Treib, particularly with increasing light. Yamaguchi (1983) determined that the recommended temperature range for production of kohlrabi is 18-25 °C, with the optimum at 22 °C. Also, it has been suggested by Krug (1991) that a temperature of at least 12 °C is needed during the growing period of kohlrabi.

In the spring growing period, tuber weight, tuber diameter and yield ranged between 495.6 and 762.0 g, 94.8 and 107.2 mm and 9.787 and 15.616 kg respectively, depending on cultivars (Table 4). These results are in agreement with those of Glukhov (1973), who obtained 23 t ha-1 yield in kohlrabi, and Krug (1991), that suggested tuber diameter must be more than 40 mm for fresh market, but average tuber weight values are higher than those of Mehwald (1976), in which he reported that average tuber weight varied in 430 to 475 g in nine kohlrabi cultivars. Among cultivars, the highest tuber values were obtained from Neckar and E. Forcer. The authors hypothesize that Lahn did not do well due to sensitivity to different ecological conditions, although cv. Lahn is recommended as summer crop in the north-west Europe (Rickzwaan, 2000). Also, Vanparys (1999), working with twelve kohlrabi cultivars to determine the best cultivar for industrial processing, found that Lahn gave the lowest tuber weight among cultivars. In this study, although leaf number of Neckar was less than other cultivars, this

cultivar had the highest leaf weight and area. The highest tuber weight, diameter and yield were obtained from Neckar. This can be attributed to increases in photosynthetic efficiency as depend on large assimilation surface and suitable shape, size, position and number of cell layers of photosynthetic tissue. In terms of tuber weight, generally, 6 week old seedlings of cultivars, except for Lahn, were heavier than 4 week old seedlings (Table 5). It is commonly regarded that seedling development level is related to growing conditions, especially in relation to temperature and it is recommended that the lowest day temperatures should be 12-15 °C during seedling growing period in kohlrabi (Fink and Krug, 1989; Wiebe et al., 1992). Unsuitable weather conditions before first planting time may reduce the seedling growth level. Regarding tuber index, only the index value of 6 weeks old seedling of Lahn planted on 3 April were less than one (Table 4, 5). This situation relates cultivar and seedling growing conditions. Fritz and Stolz (1989) suggested that weather conditions (especially cool weather) influence tuber formation in some varieties.

During the fall growing period, the highest tuber weight, diameter and yield were produced by E. Forcer (Table 7). Within the studies carried out in different places utilizing different cultivars, Vanparys (1996) reported that E. Forcer was the highest among twenty one kohlrabi varieties in term of yield, Vanparys (1988) suggested that E. Forcer was one of the best suited cultivars for the fresh market, Lippert (1995) demonstrated that E. Forcer was more resistant to cracking than other varieties, and Habegger and Wiebe (1986) indicated that cultivar E. Forcer remained in marketable quality at maturity after a 9-week vernalization treatment at 6 °C. During this period, Lahn was ranked lowest in the characteristics mentioned above. Both 4 week old seedlings of E. Forcer and Lahn gave higher tuber diameter and yield, compared to Neckar (Table 9). This result indicates that the 4 week seedling growing period was sufficient for the fall season. These findings are consistent with the reports of Janssen (1983), who determined that the development period of kohlrabi seedlings was short in summer and longer in winter, Muehmer et al., (1987), stated that older transplants resulted in elongated plants, and delayed maturity, rough fruit, decreased yield and poorer grades. Despite the lower leaf weight and area of E. Forcer, it had the highest leaf number, tuber ratio, and the highest yield and yield components. These results indicate that E. Forcer has a higher number of narrow, light leaves with a large part of the plant consisting of tuber. Although the only significant difference observed was between planting dates, generally, tuber weight, diameter, yield of plants planted on 2 October were greater than those of the first two fall planting dates due to more suitable environmental conditions for kohlrabi.

Leaf area varied from 9.2 to 13.1 dm2 (Table 3) in spring season and from 11.4 to 16.1 dm2 (Table 6) in the fall. These results correspond with those of Sritharan and Lenz (1992) where measured leaf area was between 8.4 and 12.4 dm2 in different light regimes. In both growing seasons, Lahn had the highest value with regards to SSC. This can be attributed to the cultivar properties of Lahn.

In conclusion, cultivars Neckar or E. Forcer can be suggested for both growing seasons, utilizing six week old seedlings in the spring, and four week old seedling in the fall. Planting dates did not have a clear effect in spring and the last planting date in fall little positive effect on tuber properties and yield. Further research is needed regarding cultivar selection and should be carried out for the improvement of the results presented above.

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