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Response of two broccoli varieties to different sowing dates

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SUMMARY: An experiment was carried out in the vegetable field managed by the Department of Horticulture and Landscape Design, located within the College of Agriculture and Forestry at the University of Mosul, during the fall growing season of 2024 to study the physiological effects of three broccoli sowing dates (10 August, 20 August, and 1 September) using two hybrid varieties of broccoli plants: Matsuri Japanese hybrid, Lotus Dutch hybrid, thus the experiment included 6 factorial treatments (2*3) implemented in the field using a factorial experiment in a complete randomized block design RCBD with three replicates. The results of the statistical analysis using the SAS electronic program and at a probability level of 5% according to Duncan's multiple range test showed the following: sowing broccoli on the first date is preferred in order to increase productivity traits, and the Lotus variety significantly outperformed the Matsuri variety in productivity traits. Cultivating the Lotus hybrid during the first sowing date (10 August) resulted in marked improvements across all productivity-related traits.

The interaction effect between sowing date and cultivars showed a significant individual effect for each factor and each trait.

Keywords: : Broccoli, Sowing date, Nineveh. Production

Key findings: Sowing broccoli on the first date is preferred in order to increase productivity traits, and the Lotus variety significantly outperformed the Matsuri variety in productivity traits. sowing on the first date with the use of the Lotus hybrid led to significant increases in all productivity traits. The interaction effect between sowing date and cultivars showed a significant individual effect for each factor and each trait.

.INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica*), classified as a winter-season vegetable crop (Hassan, 2004), is celebrated for its exceptional nutritional and medicinal value. Renowned as the most nutritionally dense member of the cruciferous family, broccoli is also extensively studied for its medicinal properties due to its composition of vitamins (A, B1, B2, B5, B6, B17, E), vital nutrients (Thapa & Rair, 2012), and bioactive anti-cancer phytochemicals (Griffin, 2006). Globally, broccoli and cauliflower production reached approximately 22.8 million tons annually, with China contributing 43% of total output. Iraq's production, by contrast, amounted to 31,178 tons, representing 0.14% of global yields (FAO, 2022).

Modern agricultural research emphasizes enhancing production efficiency through high-yield cultivars, whether hybrid or conventional. Hybrid and conventional varieties demonstrate differing yield potentials influenced by genetic characteristics and environmental factors during cultivation phases. Optimal production economics rely on developing cultivars with superior yields and quality traits that meet consumer preferences (Ibraheem, 2007), alongside strategies to prolong market availability. Successive planting—cultivating identical or complementary varieties at strategic intervals within a single growing season, particularly emphasizing early-season establishment—enables extended harvest windows and sustained market supply(Al-Habar and Al-Rashidi, 2014). The planting date for any crop is determined by the prevailing conditions in the production area, most notably light and heat, as well as the agricultural methods used in production, in terms of using some techniques to reduce or increase light and heat, using some modern irrigation methods, and choosing varieties (hybrids or pure, early, late) in modifying the planting date for any crop. Therefore, we find that the planting date for a single crop differs from one region to another in the world and also differs within a single country. For this reason, many applied studies have been conducted in different regions of the world to determine the best planting date for all production areas.

This study seeks to enhance the growth and yield of broccoli plants by identifying the optimal sowing date and most suitable cultivar, while also evaluating the interaction between these factors to determine the highest-performing combination.

MATERIALS AND METHODS

The study was implemented in a sandy soil vegetable field managed by the Department of Horticulture and Landscape Design, College of Agriculture and Forestry, University of Mosul, Iraq, during the 2024 fall growing season. The experiment assessed two variables: (1) the physiological impact of three broccoli sowing dates (10 August, 20 August, and 1 September) and (2) the performance of two hybrid broccoli cultivars (*Brassica oleracea* var. *italica*), with the goal of identifying optimal combinations for growth and yield: Matsuri Japanese hybrid, Lotus Dutch hybrid. The factorial experiment employed a 3×2 design (three sowing dates × two hybrids), resulting in six treatments arranged in a split-plot system under a randomized complete block design (RCBD) with three replications. Each experimental unit consisted of three rows measuring 1.75 m in length, spaced 75 cm apart, and containing five plants per row (15 plants total per unit). The total area per experimental unit was 3.9375 m^2.

Seeds for each sowing date were initially planted in plastic trays with 50-cell cavities filled with peat moss as the growth medium. Seedlings were transplanted into the permanent field during morning hours once they developed 3–4 true leaves. Care was taken to retain peat moss around the root system during transplantation, and soil moisture was maintained post-transplant. Drip irrigation was utilized throughout the trial.

All agronomic practices followed standard protocols for commercial crop production, including irrigation tailored to plant requirements. Notably, cultivation guidelines for squash were referenced for fruit production optimization, though adjustments were made to align with broccoli-specific needs.

Statistical analysis

Statistical analysis was performed using SAS (2017), with mean comparisons conducted via Duncan's multiple range test at a significance level of 0.05 (AL-Rawi & Khlaf Allah, 2000).

Parameters studied

1- Total chlorophyll percentage in leaves (%): This trait was measured using the (SPAD) device at a rate of 10 readings per leaf, then the average was extracted.

2- Plant height (cm. $plant^{-1}$): Measured from the base of the stem at soil level to the apex of the tallest leaf.

3- leaf count (leaf. $plant^{-1}$): Total number of fully expanded leaves per plant, excluding underdeveloped or rudimentary leaves.

4- Curd formation rate (days) It was calculated according to the following equation: Curd formation rate = total (number of curds formed × days to appearance from sowing\ Total number of curds

5- Days to 20% curd maturity (day): Determined by recording the number of days from sowing until 20% of curds in the experimental unit reached harvestable maturity.

6- Mean weight of curd (g. $curd^{-1}$) It was calculated by dividing the total fresh weight of the main curds harvested per experimental unit by the corresponding number of curds.

7- Curd yield (ton. ha^{-1}): Estimated using the question Total curd weight per experimental unit (kg)×10,000 \ experimental unit area (m^2)

8- Circumference of curd (cm) Measured as the widest circumference of the primary curd using a flexible tape, averaged across ten plants per experimental unit.

RESULTS AND DISCUSSION

Data presented in Table (1) demonstrate that the second sowing date significantly outperformed the first sowing date only in the total chlorophyll content of leaves, while the Lotus hybrid was significantly superior to the Matsuri hybrid in this trait. The interaction analysis revealed that the combination of the first sowing date when using the Lotus hybrid resulted in the most pronounced increase in chlorophyll content, achieving a value of 60.220 SPAD, which was statistically superior to all other treatment combinations.

Data from Table No. (2) show that there are no statistically significant differences in plant height ($cm \cdot plant^{-1}$) between the individual experimental factors or their interactive combinations.

The data shown in Table (3) indicate that the first sowing and second dates were significantly superior to the plants sowing in the last date 1/9 in the number of leaves. The plants of the first two dates 10/8 and the second 20/8 did not differ significantly in this trait, while the Lotus hybrid plants exhibited significantly higher leaf counts compared to the Matsuri hybrid. The interaction analysis revealed that the first sowing date (10 August) with the Lotus hybrid produced the highest leaf count 22.133 leaves $plant^{-1}$ which was statistically superior to both the Lotus hybrid sown on 20 August and all Matsuri hybrid treatments.

The results in Table (4) indicate that the Plants sown on the second date (20 August) required the fewest days to curd formation, with a significant reduction compared to the third date (1 September). Hybrid type alone showed no significant differences in this trait. However, the interaction of the first sowing date (10 August) with the Lotus hybrid resulted in the shortest curd formation period (90.550 days), while the Matsuri hybrid sown on the third date (1 September) required the longest duration (106.700 days).

The results shown in Table (5) indicate delayed sowing dates significantly increased the time required for 20% curd maturity. Plants sown on the first date (10 August) reached harvestable maturity earliest (139.000 days), differing significantly from the third-date treatments. The Lotus hybrid also matured faster (136.000 days) than the Matsuri hybrid. The interaction of the first sowing date (10 August) with the Lotus hybrid achieved the shortest maturity period, underscoring its advantage in reducing time to harvest., while the highest number of days for this trait was recorded in Matsuri hybrid plants overlapping with the late planting date (156,000).

The results in Tables (6 and 7) indicate that the Plants sown on the first date (10 August) exhibited significantly higher mean curd weight and total curd yield compared to those sown on 20 August and 1 September, with increases of 39.49% and 96.73%, respectively. The second sowing date (20 August) also outperformed the third date (1 September) in both traits. The Lotus hybrid consistently surpassed the

Matsuri hybrid in curd weight and yield. Interaction analysis revealed a progressive decline in curd weight and yield for both hybrids as sowing was delayed. The Lotus hybrid sown on 10 August achieved the highest mean curd weight (543.20 g·curd^{-1}) and total yield (20.703 t·ha^{-1}), significantly exceeding all other treatment combinations.

The results in Table (8) Plants from the first sowing date (10 August) produced curds with significantly larger circumferences compared to later dates, with a gradual reduction observed as sowing was delayed. No significant differences were detected between the Lotus and Matsuri hybrids for this trait. However, the interaction analysis showed that Matsuri hybrid plants sown on 10 August yielded the largest curd circumference (46.733 cm·curd^{-1}), which was statistically superior to all other combinations.

Table 1: Effect of sowing dates, cultivars and interaction on the percentage of chlorophyll content of leaves.

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	27.013 d	56.867 ab	47.793 b-c	43.8911 b
Lotus	60.220 a	45.267 c	50.467 a-c	51.9844 a
Average Sowing date effect	43.617 b	51.067 a	49.130 ab	

Means share shames alphabetical letter not different significantly each to other according to Duncan's multiple range test at the 5% probability level (**)

Table 2: Effect of sowing dates, cultivars and interaction on plant height

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	71.667 a	73.867 a	72.867 a	72.800 a
Lotus	74.667 a	73.733 a	72.733 a	73.711 a
Average Sowing date effect	73.166 a	73.800 a	72.800 a	

(**)

Table 3: Effect of sowing dates, cultivars and interaction on leaves number

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	18.866 c	19.266 c	19.000 c	19.044 b
Lotus	22.133 a	21.600 a	20.933 b	21.555 a
Average Sowing date effect	20.500 a	20.433 a	19.966 b	

(**)

Table 4: Effect of sowing dates, cultivars and interaction on curd form

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	96.166 b	94.000 c	106.700 a	98.955 a
Lotus	90.550 d	90.616 d	104.850 a	95.338 a
Average Sowing date effect	93.358 b	92.308 b	105.775 a	

(**)

Table 5: Effect of sowing dates, cultivars and interaction on 20% of curds matured and harvested

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	154.000 a	149.000 ab	156.000 a	153.000 a
Lotus	124.000 d	138.000 c	146.000 b	136.000 b
Average Sowing date effect	139.000 b	143.500 b	151.000 a	

(**)

Table 6: Effect of sowing dates, cultivars and interaction on weight of curd

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	428.93 b	313.73 c	237.63 d	326.77 b
Lotus	543.20 a	383.20 b	256.53 cd	394.31 a
Average Sowing date effect	486.07 a	348.47 b	247.08 c	

(**)

Table 7: Effect of sowing dates, cultivars and interaction on yield of curds

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	16.348 b	11.957 c	9.057 d	12.453 b
Lotus	20.703 a	14.605 b	9.777 cd	15.028 a
Average Sowing date effect	18.525 a	13.281 b	9.417 c	

(**)

Table 8: Effect of sowing dates, cultivars and interaction on circumference of curds

Cultivars	Sowing date			Average cultivars effect
	10\8	20\8	1\9	
Matsuri	46.733 a	38.800 bc	36.733 c	40.756 a
Lotus	42.067 b	36.800 c	31.867 d	36.911 a
Average Sowing date effect	44.400 a	37.800 b	34.300 c	

(**)

In an overview of the results presented when discussing the traits under study, it was noted that first sowing led to a significant increase in production and quality traits compared to the second and third sowing dates. This may be due to the exposure of plants planted at the first date to more suitable climatic conditions for growth, such as an increase in temperature. Therefore, these conditions encouraged an increase in indicators of vital processes in the plant, such as photosynthesis, food production, and better absorption of nutrients from the soil, as well as due to the increase in the appropriate growth period that the plants of the first date were exposed to in the field until harvest. Our significant results achieved when planting plants at early dates and with different studied traits of the production yield were consistent with the results of (Abou El-Yazid et al., 2007), (Abou El-Magd, 2013), (Getuchew, 2016), (Latif et al., 2019), and (Al-Zubaidi, 2020). The significant differences between the two varieties under study in the mentioned traits may be due to the differences in the genetic compositions between the two varieties (and the extent of each variety's response to environmental conditions, and thus the emergence of variation between the varieties in the studied trait (Ibraheem and Mahmoud, 2024) and (Hussein and Ibraheem, 2023) and (Ahmad et al., 2024) and (Al-Sultan et al., 2023) and (Ibraheem and Mahmoud, 2024). These results were consistent with what was found by (Abou El-Magd et al., 2006) and (Omer and Abdul, 2013) and (Al-Moussawi and Al-Birmani, 2017) and (Al-Salihi, 2019).

CONCLUSIONS

This study demonstrates that early sowing (10 August) significantly enhances broccoli productivity traits, with the Lotus hybrid outperforming the Matsuri hybrid across all yield-related parameters. The synergistic effect of combining the first sowing date with the Lotus hybrid resulted in marked improvements in curd weight, yield, and maturation efficiency. These findings underscore the efficacy of adopting the first sowing date (10 August) paired with the Lotus hybrid as a strategic agronomic practice to optimize broccoli production. Implementing this approach in commercial cultivation is strongly recommended to maximize yield and quality under similar climatic and soil conditions.

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