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# Effect of Plant Density in Yield and Quality of Two Flax Cultivars (*Linum usitatissimum* L.)

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## ABSTRACT

This experiment was conducted at Grdarasha Research Station of Agriculture College- Salahaddin University, Erbil/Iraq, during winter season 2013-2014 to determine the influence of row and plant spacing with flax cultivars and their interactions on yield and quality. A factorial experiment was used based on randomized complete block design, with three replications, three row spacing; 10, 20, and 30 cm, three plant spacing within row; 4, 6, and 8 cm in addition to two cultivars; Local and Polish (Thorshansity 72). Plants cultivated at 30 cm row spacing recorded the highest values of plant height (77.2cm), stem diameter (2.78mm), number of primary branches/plant (6.4), number of capsules/plant (39.1), seed yield (2.107 t $ha^{-1}$) and oil content (22.8%). Plants cultivated at 4 cm and 6 cm between tplants recorded the highest seed yield (1.981 t $ha^{-1}$) and oil content (22.4%) respectively. Thorshansity 72 cultivar produced the highest stem diameter (2.74 mm), number of primary branches/plant (7), number of capsules/plant (35.8), seed yield (1.782 t $ha^{-1}$), and oil content (22.7%). The best dual plant densities are (10 cm × 8 cm) and (20 cm × 6 cm) which produced the highest seed yield (2.240 t $ha^{-1}$) and oil content (23.3%) respectively. Thorshansity 72 cultivar produced the highest value of seed yield and oil content (2.188 t $ha^{-1}$ and 24.0%) respectively when planted at 30 cm row spacing, the same cultivar produced the highest oil content (24.1%) when was planted at 6 cm plant spacing. Thorshansity 72 cultivar produced the highest seed yield (2.402 t $ha^{-1}$) when planted at (10 cm × 8 cm), while the same cultivar gave the highest oil content (26.8%) when planted at (20 cm × 8 cm). Flaxseed cultivars yield and oil varied greatly in response to different plant densities with two and three-way interactions of factors.

# تأثير الكثافة النباتية على حاصل ونوعية صنفين من الكتان (*Linum usitatissimum* L.)

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## الخلاصــة

نفذت هذه التجربة في محطة بحوث كردرشة التابعة لكلية الزراعة–جامعة صلاح الدين–اربيل/العراق خلال الموسم الشتوي ٢٠١٣–٢٠١٤ لتحديد تأثير مسافات الزراعة بين السطور وبين النباتات على حاصل ونوعية صنفين من الكتان. طبقت تجربة عاملية في تصميم القطاعات العشوائية الكاملة وبثلاثة مكررات، مثلت (١٠و٢٠ و٣٠ سم) المسافات بين السطور و(٤و٦ و٨ سم) المسافات بين النباتات ضمن السطر بالاضافة الى زراعة الصنفين المحلي والبولوني (Thorshansity 72). سجلت النباتات المزروعه بمسافه ٣٠ سم بين السطور أعلى قيم في ارتفاع النبات (٧٧،٢ سم) وقطر الساق (٢،٧٨ ملم) وعدد الأفرع الأولية للنبات (٦،٤) وعدد الكبسولات في النبات (٣٩،١) وحاصل البذور (٢،١٠٧ طن/هـ) ونسبة الزيت (٢٢،٨٪). أنتجت النباتات المزروعة على مسافات ٤ و٦ سم بين النباتات أعلى حاصل البذور (١،٩٨١ طن/هـ) ونسبة الزيت (٢٢،٤٪) على التوالي. أنتج الصنف البولوني أعلى قطر الساق (٢،٧٤ ملم) وعدد الأفرع للنبات (٧) وعدد الكبسولات للنبات (٣٥،٨) وحاصل البذور (١،٧٨٢ طن/هـ) ونسبة الزيت (٢٢،٧٪). أفضل كثافة نباتية ثنائية (١٠ سم × ٨ سم) و(٢٠ سم × ٦ سم) التي اعطت أعلى قيم لحاصل البذور (٢،٢٤٠ طن/هـ) ونسبة الزيت (٢٣،٣٪) على التوالي، وكذلك أنتج الصنف البولوني أعلى حاصل البذور (٢،١٨٨ طن/هـ) والزيت (٢٤٪) عندما زرع على مسافة ٣٠ سم بين السطور، وأعطى نفس

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الصنف أعلى نسبة الزيت (٢٤،١٪) عندما زرع على مسافة ٦ سم بين النباتات. أنتج الصنف البولوني أعلى حاصل البذور (٢،٤٠٢ طن/هـ) عندما زرعت على مسافات (١٠ سم × ٨ سم) وأعطى نفس الصنف أعلى نسبة الزيت (٢٦،٨٪) عندما زرع على مسافات (٢٠ سم × ٨ سم). تغير حاصل وزيت اصناف الكتان لحد كبير عند الكثافات النباتية المختلفة، مع التداخلات الثنائية والثلاثية للعوامل.

## Introduction

Flaxseed (*Linum usitatissimum* L.) is an herbaceous plant that belongs to the linaceae family. The seed contains about 38% oil (Rabetafika *et al*., 2011). The edible flaxseed oil is used for human consumption and contains linolenic acid; polyunsaturated fatty acid that is known to have nutritional and health benefits (Morris, 2005). However, among agricultural agronomic practices, spacing is one of most important agronomic factors that have great impact on growth and yield. Appropriate planting pattern (distance between rows and between plants) might be considered the determined factor in preparing suitable spatial space for growing plants and yield. Furthermore, each yield component is affected by many factors, including genotype and agricultural practices such as plant density, and the main impact of plant density on yield is due to difference in distribution of solar energy and increasing light which leads increasing yield (Drouet and Kiniry, 2008). Andruszczak *et al*. (2015) and Santos *et al*. (2016) reported that the number of capsules per plant were increased by wide row spacing or low density respectively. Stevenson and Wright (1996) show that row spacing is agricultural practices that affect flaxseed yield; seed yield was 9% greater in the 9 cm row spacing (1341 kg $ha^{-1}$) as compared to the average at 18 and 27 cm row spacing. Kocjancko and Trdan (2008) revealed that the highest average yield of the seeds was obtained from the 17 cm row spacing, (1.52 t $ha^{-1}$). Darby *et al*. (2013) reported that planting at narrow row spacing (11.43 cm) yielded the highest at 531.3 kg $ha^{-1}$. Dias *et al*. (2014) showed that among different row spacing, the 30 cm (which did not differ from 15 cm) produced the highest yield (1130.7 kg $ha^{-1}$) compared with 45 cm which produced 55% less than 30 cm row spacing. Mohammed (2014) found that the oil content of safflower had significant effect by row spacing, the maximum oil content (36.6%) was at 50 cm row spacing compared with narrow rows; the same researcher showed that increase in seed oil (39.3%) at (50 cm × 15 cm) or low density (133300 plants $ha^{-1}$). Specifically, the aim of this study was to investigate the effects of plant density (between rows and between plants) in yield and quality of two flax cultivars.

## Materials and Method

This experiment was conducted at Grdarasha Researches Station of Agriculture College-Salahaddin University-Erbil, during winter season of 2013-2014 to study the effect of row and plant spacing on seed yield and quality of two flax cultivars. A factorial experiment was used based on randomized complete block design, with three replications, three row spacing: 10, 20, and 30 cm represented the first factor, the second represented three plant spacing within row: 4, 6, and 8 cm, and the third was two cultivars local and Thorshansity 72 (Polish cultivar). The field was irrigated with water to facilitate the plowing process and preparing the good seedbed and also to promote weed seeds germination, then plowed twice, softened and leveled. The physical and chemical properties for soil of experimental location are represented in table (1). The farm was divided manually into plots; each replicate consists of 18 experimental unit (1 m × 1.50 m) contain five rows of one meter long. Planting was done on November 23, 2013 (Taifor and Rasheed, 1990), the seeds were distributed according to row and plant spacing combinations. Furthermore, 100 kg N/ha fertilizer was applied in form of urea (46% N) at two intervals; half amount was added at planting and the second at flowering stage (Hassen and Shaker, 2013). At planting, 200 kg $P_2O_5$ $ha^{-1}$ in form of triple superphosphate (46% $P_2O_5$), was drilled near the rows and covered (Esmail *et al*., 2014).

The following characteristics were evaluated: plant height (main stem length was measured from ground level to just below the first apical), stem diameter (mm) was measured using a precision caliper at 3 cm from the base of the plant, and the number of fruiting branches per plant. The

number of capsules per plant was estimated by counting five plants samples per plot; numbers of seeds per capsule and 1000-seed weight were calculated too.

The final harvest for seed yield was determined when more than 75% of the capsules had turned brown and seed rattled in the capsules when they were shaken, after harvest; plants were air-dried for about 15 days. Seeds were threshed manually; the seeds were then cleaned and weighed. Oil was extracted from flax seeds using Soxhlet and oil percentage was estimated according to Association of Official Analytical Chemists (A.O.A.C.,1980).

The results were submitted to analysis of variance using (SAS, 2005) and the interaction between factors and their means were compared by using Duncan's multiple range test at 5% probability (Steel and Torrie, 1960).

**Table 1. Some physical and chemical properties of experiment soil**

| Clay (%) | Silt (%) | Sand (%) | Soil texture | pH | Ec (ds $m^{-1}$) | O.M (g $kg^{-1}$) | Total N (g $kg^{-1}$) | P (mg $kg^{-1}$) soil | Solubale cations $K^+$ (m $mole^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| 45.0 | 42.5 | 12.5 | Silt clay | 7.42 | 0.2 | 10.9 | 0.18 | 3.75 | 0.10 |

The soil properties tests were conducted at the Directorate of Agriculture Research Center /Erbil

## Results and Discussion

It was found that 30 cm row spacing and 6 cm plant spacing attained the highest plant height (77.2 and 78.2 cm) respectively, compared with rest of treatments (Tables 2 and 3). In table 5, the data showed that plants cultivated at 30 cm row spacing with 6 cm plant spacing (low density) achieved the highest plant height (83.9 cm), this result was in agreement with Santos *et al*. (2016) who mentioned that the highest of plant height obtained from 100 plants $m^{-2}$ (low density). Thorshansity 72 cultivar recorded the highest plant height (77.9 cm) when planted at 30 cm row spacing . Local cultivar also recorded the highest plant height (85.7 cm) when planted at 30 cm row spacing with 6 cm plant spacing compared with other three-way interaction (Table 6). This variation is due to cultivars response difference to the distance between row and plant spacing. This result is not in agreement with Gabiana *et al*. (2005) who mentioned that increased plant density had a negative effect on plant height, the highest plants belonged to the lowest density plots and with Dias *et al*. (2014) who found that when flaxseed was grown at large spacing (0.45 m), it had no influence on plant height.

The results in tables 2, 4, 5, and 6 show significant differences in stem diameter between row spacing, cultivars and the all of two-way and three-way interactions. The cultivated plants at wider row spacing (30 cm) led to increase stem diameter which produced highest rate for this trait (2.78 mm) compared to narrow row spacing. Also Thorshansity 72 cultivar recorded the largest stem diameter (2.74 mm) compared to the local cultivar. The largest stem diameters (2.92, 2.99, and 2.77 mm) were observed at (30 cm × 4 cm), Thorshansity 72 cultivar at 30 cm row spacing and the same cultivar at 6 cm plant spacing respectively. Thorshansity 72 cultivar recorded the largest stem diameter (3.28 mm) when planted at 30 cm row spacing with 4 cm plant spacing.

It is noticed that plants planted at 30 cm row spacing and Thorshansity 72 cultivar gave the highest number of primary branches per plant (6.40 and 7.00) (Tables 2 and 4) respectively. This variation is due to planting flax by wide row spacing leads to the formation of intensive vegetation growth, decrease of stem length with largest stem diameter (Table 2) and thus increase the efficiency of photosynthesis process which reflected increase of plant branching. This result is in agreement with Gabiana *et al*. (2005) who showed that branching was inhibited in high density plots. Thorshansity 72 cultivar gave the highest rate for this trait of (8.03 and 7.46) when planted at 30 cm row spacing and at 4 cm plant spacing respectively compared with the other treatments (Table 5). Also, this cultivar gave the highest number of primary branches (9.67) when cultivated at 30 cm between rows with 4 cm between plants compared with the local cultivar which gave the

lowest rate for this trait (4.10) when cultivated at 10 cm row spacing with 8 cm plant spacing (Table 6).

It was found that plants cultivated at 30 cm row spacing, at 4 cm plant spacing and Thorshansity 72 cultivar gave the highest number of capsules per plant reached (39.1, 39.7, and 35.8) respectively, (Tables 2, 3, and 4), this was due to increasing the number of primary branches per plant and consequently increase the number of capsules per plant. This result is in agreement with Gabiana *et al*. (2005) who found that increased plant population (narrow spacing) reduced number of capsules per plant production and hence seed yield. According to table 5, it was found that plants cultivated at 30 cm row spacing with 6 cm plant spacing and Thorshansity 72 cultivar plants when planted at 30 cm row spacing gave the higher rate of capsule numbers per plant reached (41.5) and (45.3) respectively, also the same cultivar gave the highest number of capsules per plant (56.1) when planted at (30 cm × 4 cm) between row and plant spacing (Table 6).

The results of tables 2, 3, and 4 indicate that crop grown at 30 cm row spacing, at 4 cm plant spacing and Thorshansity 72 cultivar gave the highest seed yield in comparison with the rest of treatments. The increase in yield was due to increasing one or more of its components such as number of capsules per plant. This result is in agreement with Lafond (1993) and Dias *et al.* (2014) who revealed that the highest seed yield was obtained for plants cultivated at 30 cm row spacing, and this was not in agreement with Kocjancko and Trdan (2008) who mentioned that the average yield of seeds obtained from the 17 cm row spacing was significantly the highest (1.52 t $ha^{-1}$), as well as not in agreement with Stevenson and Wright (1996) who showed that seed yield was 9% greater in the 9 cm row spacing (1341 kg $ha^{-1}$) as compared to the average in the 18 and 27 cm row spacing (1254 and 1203 kg $ha^{-1}$) respectively. Table 5 showed that plants cultivated at 10 cm row spacing with 8 cm plant spacing and Thorshansity 72 cultivar when planted at 30 cm row spacing produced the highest rate of seed yield reached (2240.0 and 2187.9 kg $ha^{-1}$) respectively, also from table (6) Thorshansity 72 cultivar gave the highest yield when planted at 10 cm row spacing with the 8 cm plant spacing (2401.9 kg $ha^{-1}$).

The results in tables 2, 3, and 4 indicated that plants cultivated at 30 cm row spacing, at 6 cm plant spacing and Thorshansity 72 cultivar recorded the highest oil content reached 22.8, 22.4, and 22.7% respectively, this result was in agreement with Ozel *et al*. (2004) who indicated that the intra row spacing had the highest oil content of safflower (35.5%) was obtained at 5 cm plant spacing, while the lowest oil was at 10 cm plant spacing. Also plants cultivated at low density (20 cm × 6 cm) which did not differ from (30 cm × 6 cm), Thorshansity 72 cultivar when was planted at 30 cm row spacing and at 6 cm plant spacing produced the highest oil content reached (23.3, 24.0, and 24.1%) respectively, this was in agreement with Abd El-Mohsen and Mohmoud (2013) who showed that increase in seed oil percentage of safflower from (30.5 to 34.5%) respectively by decreasing plant density from 200000 to 80000 plants $ha^{-1}$. (Table 5), as well as it gave the highest oil content (26.8%) when planted at 20 cm row spacing with 8 cm plant spacing (Table 6).

It is concluded that crop grown at 30 cm row spacing, at 4 cm plant spacing and Thorshansity 72 cultivar was superior at containing the highest seed yield (2.0, 2.0 and 1.8 t $ha^{-1}$) respectively, also planting at 30 cm row spacing, 6 cm between plants and Thorshansity 72 cultivar produced the highest oil content. Thorshansity 72 cultivar planted at 30 cm row spacing surpassed by seed yield and oil content, and the same cultivar planted at 8 cm and 6 cm plant spacing surpassed by yield and oil content respectively. Thorshansity 72 cultivar planted at plant densities (10 cm × 8 cm) and (20 cm × 8 cm) surpassed by yield and oil content respectively. In addition, planting at 30 cm row spacing, 6 cm plant spacing, (30 cm × 6) cm and Thorshansity 72 cultivar at 30 cm row spacing gave the highest stem length. Also, planting at 30 cm row spacing, Thorshansity 72 cultivar, (30 cm × 4 cm), Thorshansity 72 cultivar planted at 30 cm row spacing and the same cultivar planted at 6 cm plant spacing gave the highest stem diameter. Therefiore, We recommend planting flaxseeds of wide row spacing (30 cm) and narrow plant spacing (4 cm) because it produced high yield, in addition to, planting of plant spacing (6 cm) to produce the highest oil content. Also, planting

Thorshansity 72 cultivar of densities (10 cm × 8 cm) and (20 cm × 8 cm) due to its surpassingness in yield and oil content respectively.

**Table 2. Effect of row spacing on some growth characteristics, yield, yield components and oil content of two cultivars of flax**

| Row spacing (cm) | Total stem length (cm) | Stem diameter (mm) | No. of branches/ plant | No. of capsules/ plant | No. of seeds/ capsule | 1000-seed weight (g) | Seed yield (kg ha$^{-1}$) | Oil content (%) |
|---|---|---|---|---|---|---|---|---|
| 10 | 71.6b | 2.41b | 5.29b | 26.8b | 7.5a | 13.6a | 1144.5b | 19.1b |
| 20 | 75.9ab | 2.59ab | 5.64b | 30.9ab | 7.5a | 13.8a | 1180.0b | 21.8a |
| 30 | 77.2a | 2.78a | 6.40a | 39.1a | 7.9a | 13.4a | 2107.0a | 22.8a |

Values designed a different letters within columns of these tables indicates significantly differences at 5% of probability according to Duncan's multiple rang test

**Table 3. Effect of plant spacing on some growth characteristics, yield, yield components and oil content of two cultivars of flax**

| Plant spacing (cm) | Total stem length (cm) | Stem diameter (mm) | No. of branches/ plant | No. of capsules/ plant | No. of seeds/ capsule | 1000-seed weight (g) | Seed yield (kg ha$^{-1}$) | Oil content (%) |
|---|---|---|---|---|---|---|---|---|
| 4 | 74.2ab | 2.51a | 5.96a | 39.7a | 7.3a | 13.7a | 1981.5a | 19.7c |
| 6 | 78.2a | 2.67a | 5.83a | 32.9b | 7.7a | 13.6a | 1633.4b | 22.4a |
| 8 | 72.4b | 2.59a | 5.53a | 31.2ab | 7.8a | 13.5a | 1641.8b | 20.9b |

Values designed a different letters within columns of these tables indicates significantly differences at 5% of probability according to Duncan's multiple rang test

**Table4. Some growth characteristics, yield, yield components and oil content of two cultivars of flax**

| Cultivars | Total stem length (cm) | Stem diameter (mm) | No. of branches/ plant | No. of capsules/ plant | No. of seeds/ capsule | 1000-seed weight (g) | Seed yield (kg ha$^{-1}$) | Oil content (%) |
|---|---|---|---|---|---|---|---|---|
| Locally | 74.6a | 2.44b | 4.55b | 28.7b | 7.8a | 13.5a | 1522.1b | 19.3b |
| Thorshansity 72 | 75.3a | 2.74a | 7.00a | 35.8a | 7.4a | 13.7a | 1782.3a | 22.7a |

Values designed a different letters within columns of these tables indicates significantly differences at 5% of probability according to Duncan's multiple rang test

**Table 5. The two-way interactions effect on some growth characteristics, yield, yield components and oil content of two cultivars of flax**

| Two-way Interactions | | Total stem length (cm) | Stem diameter (mm) | No. of branches/ plant | No. of capsules/ plant | No. of seeds/ capsule | 1000-seed weight (g) | Seed yield (kg ha$^{-1}$) | Oil content (%) |
|---|---|---|---|---|---|---|---|---|---|
| Row spacing × Plant spacing (cm) | | | | | | | | | |
| 10 | 4 | 71.5b | 2.31b | 5.24a | 25.2c | 7.4a | 13.4a | 2123.6a | 18.0c |
| | 6 | 73.3b | 2.53ab | 5.52a | 30.9ab | 7.7a | 13.9a | 2069.8a | 21.4abc |
| | 8 | 69.9b | 2.38ab | 5.10a | 24.2c | 7.3a | 13.4a | 2240.0a | 19.0bc |
| 20 | 4 | 76.6ab | 2.51ab | 5.60a | 27.7bc | 7.1a | 13.7a | 1492.4b | 20.8abc |
| | 6 | 77.3ab | 2.56ab | 5.72a | 32.3ab | 7.2a | 13.9a | 1599.4b | 23.3a |
| | 8 | 73.9b | 2.69ab | 5.62a | 32.8ab | 8.2a | 13.7a | 1423.5b | 22.5ab |
| 30 | 4 | 74.5b | 2.92a | 7.05a | 39.1a | 7.6a | 13.8a | 1428.4b | 21.3abc |
| | 6 | 83.9a | 2.70ab | 6.27a | 41.5a | 8.0a | 13.0a | 1230.8b | 23.2a |
| | 8 | 73.4b | 2.31b | 5.88a | 36.6ab | 8.1a | 13.3a | 1261.9b | 21.4abc |
| Cultivars × Row spacing (cm) | | | | | | | | | |
| locally | 10 | 69.7b | 2.24b | 4.40c | 26.6b | 7.6a | 13.6a | 2101.0a | 17.4c |
| | 20 | 77.3ab | 2.51b | 4.48c | 26.7b | 7.5a | 13.7a | 1517.3b | 20.6b |
| | 30 | 76.7ab | 2.57b | 4.77c | 32.8ab | 8.4a | 13.1a | 1248.0b | 19.8b |
| Thorshansity 72 | 10 | 73.5ab | 2.58b | 6.17b | 26.9b | 7.3a | 13.6a | 1366.0b | 20.8b |
| | 20 | 74.6ab | 2.66ab | 6.81b | 35.2ab | 7.5a | 13.8a | 1493.0b | 23.3a |
| | 30 | 77.9a | 2.99a | 8.03a | 45.3a | 7.4a | 13.6a | 2187.9a | 24.0a |
| Cultivars × Plant spacing (cm) | | | | | | | | | |
| locally | 4 | 76.2a | 2.29b | 4.47b | 24.1a | 7.8a | 13.7a | 1670.7a | 19.4bc |
| | 6 | 73.1a | 2.57ab | 4.81b | 34.5a | 7.8a | 13.5a | 1672.5a | 21.1b |
| | 8 | 72.4a | 2.47ab | 4.37b | 27.4a | 7.9a | 13.3a | 1523.0a | 18.3c |
| Thorshansity 72 | 4 | 75.2a | 2.74ab | 7.46a | 37.2a | 6.9a | 13.6a | 1692.3a | 20.8b |
| | 6 | 74.3a | 2.77a | 6.86a | 35.2a | 7.5a | 13.8a | 1594.2a | 24.1a |
| | 8 | 73.5a | 2.71ab | 6.70a | 34.9a | 7.8a | 13.7a | 1760.6a | 23.6a |

Values designed a different letters within columns indicates significantly differences at 5% of probability according to Duncan's multiple rang test

**Table 6. The three-way interactions effect on some growth characteristics, yield, yield components and oil content of two cultivars of flax**

| Three-way interaction | | | Total stem length (cm) | Stem diameter (mm) | No. of branches/ plant | No. of capsules/ plant | No. of seeds/ capsule | 1000-seed weight (g) | Seed yield (kg ha$^{-1}$) | Oil content (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| locally | 10cm | 4 cm | 68.3b | 2.10d | 4.21de | 24.2b | 7.7a | 13.6a | 2100.5abc | 15.9i |
| | | 6 cm | 71.2ab | 2.39bcd | 4.90cde | 33.8ab | 7.9a | 13.9a | 2124.4ab | 19.8fgh |
| | | 8 cm | 69.6b | 2.23bcd | 4.10e | 28.9b | 7.4a | 13.3a | 2078.1abc | 16.5i |
| | 20cm | 4 cm | 79.8ab | 2.60a-d | 4.77de | 21.8b | 6.9a | 14.2a | 1562.1b-e | 20.7ef |
| | | 6 cm | 80.4ab | 2.49abc | 4.43de | 29.3ab | 7.4a | 13.4a | 1701.5b-e | 22.3d |
| | | 8 cm | 71.6ab | 2.45bcd | 4.23de | 24.8b | 8.0a | 13.6a | 1288.1e | 18.8h |
| | 30cm | 4 cm | 71.4ab | 2.16cd | 4.43de | 22.1b | 8.7a | 13.3a | 1349.6e | 19.5gh |
| | | 6 cm | 85.7a | 2.83a-d | 5.10cde | 40.5ab | 8.3a | 13.1a | 1191.7e | 20.3efg |
| | | 8 cm | 73.0ab | 2.72a-d | 4.77de | 35.8ab | 8.3a | 12.9a | 1202.8e | 19.6fgh |
| Thorshansity 72 | 10cm | 4 cm | 74.7ab | 2.53a-d | 6.27b-e | 26.2b | 7.1a | 13.3a | 2146.8ab | 19.2h |
| | | 6 cm | 75.4ab | 2.67a-d | 6.13b-e | 28.0ab | 7.7a | 14.1a | 2015.2a-d | 22.1d |
| | | 8 cm | 70.3b | 2.53a-d | 6.10b-e | 26.7b | 7.2a | 13.5a | 2401.9a | 21.1e |
| | 20cm | 4 cm | 73.3ab | 2.41bcd | 6.43bcd | 29.4ab | 7.2a | 13.3a | 1422.8cd | 20.4bc |
| | | 6 cm | 74.1ab | 2.63a-d | 7.00bc | 35.2ab | 7.1a | 14.3a | 1497.4cde | 23.8b |
| | | 8 cm | 76.3ab | 2.93abc | 7.00bc | 40.8ab | 8.3a | 13.8a | 1558.9b-e | 26.8a |
| | 30cm | 4 cm | 77.5ab | 3.28a | 9.67a | 56.1a | 6.5a | 14.3a | 1507.2cde | 22.8cd |
| | | 6 cm | 82.2ab | 3.02ab | 7.43b | 42.5ab | 7.8a | 12.9a | 1269.9e | 25.8a |
| | | 8 cm | 73.8ab | 2.68a-d | 7.00bc | 37.4ab | 7.9a | 13.8a | 1320.9e | 23.4bc |

Values designed a different letters within columns indicates significantly differences at 5% of probability according to Duncan's multiple range test

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