ISSN 2664-4010 (Print) & ISSN 2664-6730 (Online)
South Asian Research Journal of Agriculture and Fisheries
Abbreviated Key Title: South Asian Res J Agri Fish

| Volume-8 | Issue-2 | Mar-Apr -2026 | DOI: https://doi.org/10.36346/sarjaf.2026.v08i02.004

Original Research Article

Effect of Planting Dates on Growth and Yield of Three Kale (*Brassica oleracea* L. var. *acephala*) Cultivars

Amna Saad Hammoud[1]*, Asmaa Adnan Marie[2]
[1]College of Physical Education and Sports Sciences, Tikrit University, Iraq
[2]Department of Biology, College of Science, University of Tikrit, Tikrit, Iraq

***Corresponding Author:** Amna Saad Hammoud
College of Physical Education and Sports Sciences, Tikrit University, Iraq

Article History
Received: 16.01.2026
Accepted: 12.03.2026
Published: 20.03.2026

Abstract: The experiment was conducted during the 2022–2023 growing season at the Research Station of the Horticulture and Landscape Engineering Department, College of Agriculture, University of Tikrit, to evaluate the effect of planting dates on growth and yield traits of three kale cultivars. The study included two factors: sowing date (15 September and 1 October 2022) and cultivar (Nero di Toscana, Blue Curled Scotch, and Dwarf Siberian). The experiment was arranged in a Randomized Complete Block Design (RCBD) as a factorial with split-plot arrangement, where planting dates were assigned to main plots and cultivars to sub-plots. Mean comparisons were performed using Duncan's Multiple Range Test at $P \leq 0.05$. Results indicated significant differences due to planting dates. The 15 September sowing date was superior in most vegetative and yield traits, recording plant height (45.62 cm), stem diameter (27.94 mm), leaf area (2198.3 cm^2), total yield per plant (518.40 g), and total yield (16.98 t ha^{-1}). In contrast, 1 October showed higher germination percentage (60.87%) and germination speed (4.72 seeds day^{-1}). Among cultivars, Nero di Toscana achieved the highest germination percentage (64.83%) and plant height (45.38 cm). Dwarf Siberian surpassed other cultivars in stem diameter (29.88 mm), leaf area (1668.4 cm^2), and total yield (14.21 t ha^{-1}). The interaction of 15 September × Nero di Toscana gave the highest germination (87.56%) and plant height (56.63 cm). Meanwhile, 15 September × Blue Curled Scotch produced the greatest leaf area (4016.2 cm^2). No significant differences were observed among interactions for stem diameter, total yield per plant, and total yield. The 1 October × Dwarf Siberian interaction showed the highest germination rate (6.20 seeds day^{-1}).

Keywords: Kale, Planting Dates, Cultivars, Growth Traits, Yield.

INTRODUCTION

Kale (Brassica oleracea L. var. acephala) belongs to the family Cruciferae (Brassicaceae) from an economical point of view is one of the most important winter vegetable crops in this world. Cruciferae family includes about 372 genera and 4,060 species that are mainly annual or perennial herbs. This family encompasses a numerous variety of vegetables including cabbage, radish, broccoli, turnip, cauliflower, kale and arugula (The Angiosperm Phylogeny Group, 2009). Kale is thought to have been used as a food crop since 2000 BC. Kale was an appreciable commodity in the United States with average potato production rising from 3,994 $T \cdot ha^{-1}$ in 2007 to 6,256 $T \cdot ha^{-1}$ in year 2012 (USDA, 2012).

Kale is high in several phytonutrients, such as essential amino acids, vitamins and important minerals (Lännenpää 2014). It is also known as an antioxidant, anti-inflammatory, and anticancer. Kale is rich in the compound indole-3-carbinol that has been said to do DNA repair within cells and prevent the growth of cancerous cells (Cartea *et al*., 2011).

Kale's health benefits are subject to its high concentrations of two primary antioxidant types: carotenoids, specifically lutein and beta-carotene; and flavonoids. Kale is also rich in essential minerals like manganese and copper (antioxidants) in addition to potassium, calcium, magnesium, phosphorus, iron, omega-3 fats folic acid and vitamins as B_{12}, B_6,B_3,B_2, E,A and C's,vitamin Kale also contain a certain amount of protein resulting from by the amino acid tryptophan (Al-Gendy *et al*., 2010).

The growth and development of any crop is largely influenced by a numbers of factors, the foremost amongst which is planting date because it exerts very pronounced effect on plant' growth and productivity as well as the intensity of agricultural practices before and after sowing (Mannan and Rashid, 1983). In the same line, it is not only a scientific but also practical interest to investigate the impact of planting dates and cultivars selection on growth features and yields of kale that would provide a basis for supporting its upgrading cultivation.

These considerations have been the subject of some previous investigations. Al-Helo and Saloumi (2013) found that when arugula (Eruca vesicaria ssp. sativa) in two growing seasons and four sowing dates revealed that on 15/9/2010 and 15/2/2011, the plant height (PH), leaf area (LA) and fresh weight were significantly increased during both autumn and spring seasons. The results of study conducted by Al-Habbar and Al-Rashidi (2014) on the effect of sowing dates on yield attributes and quality of cauliflower revealed that the planting date 4/7 produced significantly higher values of number of leaves and stem diameter in comparison with the date 3/8. Abdulrahman and Yaseen (2018) showed that broccoli plants transplanted on 15/8 were the most superior to all dates in plant height (35.427 cm), leaf area (128.236 cm^2 $leaf^{-1}$), and stem diameters (26.678 mm). Anna (2010) on three hybrids of kale, indicated that hybrid Winterbor F1 produced higher leaf DM (0.45 kg m^{-2}), and plant height (155 cm); whereas Redbor F1 excelled by weight in number of leaves <22 to 28 leaves $plant^{-1}$). Olaniyi and Ojetayo (2011) also obtained differences in plant height ($plant^{-1}$ 17.50 cm), adult plant height and stem girth with the fertilization effect on growth and yield of two cabbage varieties.

MATERIALS AND METHODS

Experimental Site and Cultivation Practices

The current study was carried out at the Research Station of the Department of Horticulture and Landscape Engineering (College of Agriculture) University of Tikrit, in the autumn season 2022–2023. Seeds were planted directly in the field, two seeds per hole on two planting dates (15th September 2022 and 1st October 2022).

Before sowing, soil was prepared by ploughing with a hierarchical spike-toothed harrow and pressing down using the straightenerand proper fertilization. The experimental site was 9 m long and 4 m wide, consisting of raised beds. Plants were planted 30 cm apart and the experimental unit was composed of 10 plants. Water was supplied by drip irrigation. The experiment was arranged in 3 replications with three treatments each replication. Each experimental row was 3 m long and 53 cm wide, with plants grown in a single alternate row. The plants were raised at plant spacing.- sq. All other cultural practices such as weed control and irrigation were performed according to crop needs during the growing season (Matloub *et al*., 1989).

Experimental Factors and Design

The trial was laid out in a RCBD design as factoral experiment with spilt plot arrangement. The main plots were assigned to planting dates and subplots were assigned to kale cultivars. The experimental design was three replicates and with 12 experimental units per replicate (Al-Rawi and Khalaf Allah, 2000).

Studied Traits

Data were collected from five plants per experimental unit for the following traits:

Vegetative Growth Traits

Germination Percentage (%)

This trait was observed on the seedling stage by counting number of germinated seeds on daily basis for two weeks in Polystyrene trays.

Germination Speed (Seeds Day^{-1})

The rate of germination was calculated as the number of seeds or spores that had germinated each day over a period of two weeks at the seedling stage in polystyrene trays.

Plant Height (Cm $Plant^{-1}$)

The height of the plants was measured at the end of the experiment with a metric tape from soil surface to stem base to apical growing point, and averaged.

Stem Diameter (Mm)

The stem diameter of the main stem was measured at a constant height from soil surface by using a digital vernier caliper, and average values were taken for five plants.

Leaf Area per Plant (cm^2)

Fully expanded leaves were harvested randomly from each experiment unit to measure leaf area by the gravimetric (disc) technique. Samples were brought to the laboratory and weighed using a sensitive balance. Leaf discs of a known diameter were punched with a cork borer, weighed and the area of the disc surface calculated by:
Area of leaf discs = πr^2 x number of discs
The total leaf area per plant was then estimated using the formula:
Total leaf area = (total leaf weight / disc weight) × disc area

Yield Traits
Total Yield per Plant (g plant^{-1})
Total yield per plant was calculated by weighing the cumulative harvests and determining the average yield per plant.

Total Yield (t ha^{-1})
The overall yield was determined using the following equation:
Total yield (t ha^{-1}) = yield per plant (t) × number of plants/ha

- Number of plants per hectare for 10 plants m^{-1} (10 plants per experimental unit) = 37,499.53 plants ha^{-1}
- Number of plants per hectare for second sow date (10 plants by experimental unit) = 29,166.78 plants ha^{-1}

Statistical Analysis

Data were subjected to statistical analysis following the RCBD methodology as described by Al-Rawi and Khalaf Allah (2000) after collection and tabulation. The respective mean values of all the resulting factors, and their interactions, were compared to one another using Duncan's Multiple Range Test for significance at 0.05 probability level. We performed statistical analyses using the SAS software (version 6.2.9200 Windows).

RESULTS AND DISCUSSION

Vegetative Growth Traits

Germination Percentage (%)

The influence of planting date and cultivar on percentage germination of kale plants is presented in Table 1. The second planting date (1 October) had the highest germination percentage (60.87%) and revealed a significant advantage over the first planting date (15 September) with 58.05% germination, respectively.

In respect to cultivar effect, analysis revealed that the values of germination were also significantly different among the used cultivars; with the highest (64.83%) and lowest (52.68%) germination percentage were observed in Nero di Toscana and Blue Curled Scotch respectively.

Regarding interaction effect of planting dates × cultivar, the data showed that no treatment was similar to another. The interaction of 15 September × Nero di Toscana (S1V1) gave the highest value about germination percentage (87.56%) and was significantly different from all the other interactions. On the contrary, lowest germination percentage (26.79%) was found for interaction 15th September x Blue Curled Scotch (S 1 V2).

These variations in germination percentage could probably be due to differences in planting dates, and to the resultant ecological conditions, particularly temperature and soil moisture besides genetic difference between cultivars in seed vigor and germination potential.

Table 1: Effect of planting dates, cultivars, and their interaction on germination percentage (%) of kale

Planting dates	Nero di Toscana (V1)	Blue Curled Scotch (V2)	Dwarf Siberian (V3)	Planting date effect
15 Sept. (S1)	87.56 a	26.79 f	59.81 d	58.05 b
1 Oct. (S2)	44.98 e	76.56 b	64.95 c	60.87 a
Cultivar effect	64.83 a	51.68 c	62.20 b	—

Means followed by the same letter within columns or rows are not significantly different according to Duncan's Multiple Range Test at the 0.05 probability level.

Germination Speed (Seeds Day^{-1})

The planting dates and cultivars effects on the kale germination speed are showed in Table 2. Germination speed was highest for the second date of planting (1 October) than seeding date one (15 September), being the value very significantly different between them, with 4.72 and 2.91 seeds day^{-1}, respectively.

As far as cultivar effect is concerned, there were no differences among cultivars for germination speed.

The interaction of planting date × cultivar was also significant in all the results. The combination 1 October × Dwarf Siberian (S2V3) showed the highest rate of germination (6.20 seeds day^{-1}), being significantly higher than that observed in all other combinations. By contrast, the slowest germination speed (2.09 seeds day^{-1}) was observed for 15 September × Nero di Toscana (S1V1).

Differences in germination speed among sowing dates and between planting date*cultivar interactions could also be due to varying environmental conditions, such as temperature and soil moisture that stimulated the metabolic process of seed deterioration and germination rate.

Table 2: Effect of planting dates, cultivars, and their interaction on germination speed (seeds day^{-1}) of kale

Planting dates	Nero di Toscana (V1)	Blue Curled Scotch (V2)	Dwarf Siberian (V3)	Planting date effect
15 Sept. (S1)	2.09 c	3.98 bc	2.67 c	2.91 b
1 Oct. (S2)	5.12 ab	3.39 bc	6.20 a	4.72 a
Cultivar effect	3.61 a	3.69 a	4.44 a	—

Means followed by the same letter within columns or rows are not significantly different according to Duncan's Multiple Range Test at the 0.05 probability level.

Plant Height (Cm Plant^{-1})

Effect of planting date and cultivar Table 3 gives the results for plant height of kale. The first planting date (15 September) gave the highest mean plant height (45.62 cm plant^{-1}), which was significantly better than the second planting date (1 October).

In relation to cultivar effects, the cultivar Nero di Toscana significantly outperformed other cultivars for plant height (46.05 cm plant^{-1}). In turn, the cultivar Blue Curled Scotch at 31.48 cm plant^{-1} was shortest statured.

Regarding the effect of planting date and cultivar interaction, the 15 September × Nero di Toscana (S1V1) showed maximum plant height (56.63 cm plant^{-1}), which was significantly superior over rest of the other interactions. However, the shortest plants height (28.50 cm plant^{-1}) were recorded for 1 October × blue curled scotch (S2V2) interaction.

The significant differences in plant height can be associated with differences in environmental factors (planting date x temperature and photoperiod) as well as genotypic distances between cultivars with respect to growth vigor and adaptability.

Table 3: Effect of planting dates, cultivars, and their interaction on plant height (cm plant^{-1}) of kale

Planting dates	Nero di Toscana (V1)	Blue Curled Scotch (V2)	Dwarf Siberian (V3)	Planting date effect
15 Sept. (S1)	56.63 a	34.47 c	43.50 b	45.62 a
1 Oct. (S2)	35.47 c	28.50 d	32.74 c	32.23 b
Cultivar effect	46.05 a	31.48 c	38.12 b	—

Stem Diameter (Mm)

Influence of planting dates and cultivars: presented in Table 4, indicated that there was a highly significant difference between the effect of planting date and cultivars on stem diameter of kale. The stem diameter at 15 September planting date was the greatest (28.62 mm) and significantly different from that at 1 October.

Regarding the effect of crop, cultivar Dwarf Siberian presented significantly higher stem diameters (29.88 mm) than those observed in the remaining cultivars, while the smallest values were registred for Nero di Toscana (19.20 mm).

Significant differences were found between the interaction of planting dates and cultivars; 15 September × Dwarf Siberian (S1V3) showed the maximum stem diameter (35.83 mm) which was significantly higher than that observed for other interactions. However, smallest value of stem diameter (15.06 mm) was reported for interaction 1 October × Blue Curled Scotch (s2v2).

The differences in stem diameter might be as a result of the favorable environmental conditions resulting from an early planting which favored vegetative growth and assimilate accumulation, and genetic variation among cultivars.

Table 4: Effect of planting dates, cultivars, and their interaction on stem diameter (mm) of kale

Planting dates	Nero di Toscana (V1)	Blue Curled Scotch (V2)	Dwarf Siberian (V3)	Planting date effect
15 Sept. (S1)	19.25 d	30.78 b	35.83 a	28.62 a

1 Oct. (S2)	19.15 d	15.06 e	26.23 c	20.15 b
Cultivar effect	19.20 c	22.92 b	29.88 a	—

Means followed by the same letter within columns or rows are not significantly different according to Duncan's Multiple Range Test at the 0.05 probability level.

Total Leaf Area per Plant (cm²)

Data in Table 5 revealed highly significant differences between planting dates and cultivars with respect to total leaf area per kale plant. The laps of total leaf area were maximum at first planting date (15th September) as compared to 1st October.

As for cultivar effect, Dwarf Siberian showed higher total LA (1668.4 cm^2 $plant^{-1}$) and the lowest one (996.4 cm^2 plant 1^{-1}) was observed in Nero di Toscana.

As for the combined effect of planting date x cultivar, 15 September x Blue Curled Scotch (S1V2) presented the best total leaf area (4016.2 cm^2 $plant^{-1}$), which was significantly higher than all other interactions. On the other hand, the lowest total leaf area (980.1 cm^2 $plant^{-1}$) was determined on combination 15 September × Nero di Toscana (S1V1).

The differences in leaf area could be due to the good environmental conditions on early planted that favored vegetative growth and leaf expansion, together with genetic factors of the varieties in relation to morphological and productive potential of leaves.

Table 5: Effect of planting dates, cultivars, and their interaction on total leaf area (cm^2 $plant^{-1}$) of kale

Planting dates	Nero di Toscana (V1)	Blue Curled Scotch (V2)	Dwarf Siberian (V3)	Planting date effect
15 Sept. (S1)	980.1 d	4016.2 a	1806.3 b	2198.3 a
1 Oct. (S2)	1012.7 d	1382.6 c	1627.7 bc	1340.9 b
Cultivar effect	996.4 c	2699.4 b	1668.4 a	—

Means followed by the same letter within columns or rows are not significantly different according to Duncan's Multiple Range Test at the 0.05 probability level.

Total Yield per Plant (G $Plant^{-1}$)

The planting dates and cultivars effects on total yield per kale plant are presented in Table 6. The 1st sowing date (September 15) produced the following highest average yield per plant (518.40 g $plant^{-1}$) and was significantly superior to the (October 1) 2nd sowing date.

As for the cultivars effect, both Blue Curled Scotch and Dwarf Siberian cultivars showed statistically significant differences respect to Nero di Toscana obtaining, respectively, total yield per plant higher (373.89 g·$plant^{-1}$and 446.99 g·$plant^{-1}$).

As for the interaction of planting dates and cultivars, that of 15 September × Dwarf Siberian (S1V3) obtained the highest total yield per plant (671.35 g $plants^{-1}$) was not significantly different from S1V2 (578.00 g $plants^{-1}$). Both these cases significantly exceeded all other treatments. The least total yield per plant (168.07 g $plant^{-1}$) was noticed in the interaction combination 1 October × Blue Curled Scotch (S2V2).

The increased yield per plant in early sowing might be due to the improved vegetative phase, leaf area expansion and assimilate partitioning that led to increased micro- and macroyield.

Table 6: Effect of planting dates, cultivars, and their interaction on total yield per plant (g $plant^{-1}$) of kale

Planting dates	Nero di Toscana (V1)	Blue Curled Scotch (V2)	Dwarf Siberian (V3)	Planting date effect
15 Sept. (S1)	310.57 b	579.70 a	671.35 a	518.40 a
1 Oct. (S2)	179.51 bc	168.07 c	195.29 bc	180.96 b
Cultivar effect	245.04 b	373.89 a	446.99 a	—

Means followed by the same letter within columns or rows are not significantly different according to Duncan's Multiple Range Test at the 0.05 probability level.

Total Yield (t ha^{-1})

The effect of planting dates and varieties (cultivars) on total yield of kale the results presented in Table 7 indicated a highly significant influence of planting date, cultivar on the total yield of kale. The earliest planting (15 September) yielded significantly higher total tuber yield (16.98 t ha^{-1}) than the latest (1 October).

In terms of cultivar effects, the Dwarf Siberian cultivar yielded significantly more than other cultivars with a maximum total yield (14.21 t ha^{-1}); while the minimum total yield was decreased by Nero di Toscana with 8.21 t ha^{-1}.

Among the interaction of planting dates and cultivars 15 September × Dwarf Siberian (S1V3) was significantly superior with maximum total yield (22.14 t ha^{-1}) and was at par with interaction 15 September × Blue Curled Scotch (S1V2), which gave total yield of 19.24 t ha^{-1}. Both interactions were superior to all other treatments. The minimum total output (5.49 t ha^{-1}) was estimated in the interaction 1 October × Blue Curled Scotch (S2V2).

The advantage of early sowing in increasing the total yield could be ascribed to a lengthened vegetative period, better leaf area expansion and a greater production of assimilates, which resulted in higher grain yield/unit area.

Table 7: Effect of planting dates, cultivars, and their interaction on total yield (t ha^{-1}) of kale

Planting dates	Nero di Toscana (V1)	Blue Curled Scotch (V2)	Dwarf Siberian (V3)	Planting date effect
15 Sept. (S1)	10.44 b	19.24 a	22.14 a	16.98 a
1 Oct. (S2)	5.97 b	5.49 b	6.53 b	5.99 b
Cultivar effect	8.21 b	12.37 ab	14.21 a	—

Means followed by the same letter within columns or rows are not significantly different according to Duncan's Multiple Range Test at the 0.05 probability level.

DISCUSSION

According to the trend of studied traits, first planting time (15 September) had the most superior differences in vegetative growth compared with treatment at other times which was noticeable on plant height, stem diameter and total leaf area also total yield per plant and total yield per ha achieved from this date. This supremacy could be owing to the more appropriate weather conditions at early planting especially with proper temperature and longer day length which promotes growth in green parts enhancing yield components. On the other hand, plants of the second sowing were cultivated under unfavorable environmental temperatures (lower temperatures) and an inadequate effective growth period characterized by deprivation of sunshine exposure declining vegetative growth and fruiting formations (Abdulrahman, Mohammed, 2017). Meanwhile, the secondary sowing date was better in germination ratio and germination rate mainly because of the relatively favorable soil temp at early growing-season.

Regarding the behavior of cultivars, a wide range of results were observed amongst cultivars to the different traits studied. The variety Nero di Toscana was superior for germination percentage and plant height, while Dwarf Siberian excelled in stem diameter, total leaf area, and total yield per hectare compared to the other cultivars. Further, total yield per plant were higher for Blue Curled Scotch and Dwarf Siberian genotypes.

These large differences among the three kale cultivars are likely due to genetic differences between the different cultivars, as each has its own genetics that dictate growth and how the plant will respond to other environmental factors. Those genetic differences contributed to differences in the capacity of cultivars to tap these common environmental conditions, and with them vegetative growth and yield characters. These are consistent with the results obtained by Olaniyi and Ojetayo, (2011) on cabbage crops.

CONCLUSION

The findings of this study suggest that sowing date and variety can have very significant effects on growth and yield in kale. The 15 September planting date was dominant in most vegetative growth and yield traits, while the 1 October planting date exhibited better germination. Total yield the highest total yield was produced by Dwarf Siberian and 15 September was the best planting date for this cultivar under Tikrit conditions.

REFERENCES

- Abdulrahman, H. B. D., & Mohammed, I. A. (2017). Effect of mulching and transplanting date on growth and yield of two cauliflower hybrids (*Brassica oleracea* var. *botrytis*). *Tikrit Journal of Agricultural Sciences*, 17(4), 57–68.
- Abdulrahman, H. B. D., & Yaseen, R. A. J. (2018). Effect of transplanting dates and organic and chemical fertilization on growth and yield of broccoli (*Brassica oleracea* var. *italica*). In: *Proceedings of the 3rd International Scientific*

Conference of Agricultural Sciences – Postgraduate Studies (2019). *Kirkuk University Journal of Agricultural Sciences*.

- Al-Habbar, M. T. A., & Al-Rashidi, A. M. H. (2014). Effect of planting dates, cultivars, and boron spraying on yield quantity and quality of cauliflower (*Brassica oleracea* var. *botrytis*). *Mesopotamia Journal of Agriculture*, 42(1), 63–79.
- Al-Helo, B. R., & Saloumi, J. H. (2013). Effect of planting date and foliar application of some micronutrients on growth, yield, and medicinally active compounds content of arugula (*Eruca vesicaria* ssp. *sativa*). *Al-Furat Journal of Agricultural Sciences*, 5(1), 40–49.
- AllGendy, A. A., El-gindi, O. D., Hafez, A. S., & Ateya, A. M. (2010): Glucosinolates, volatile constituents and biological activities of Erysimum corinthium Boiss. (Brassicaceae). Food Chemistry, 118(3), 519-524 .
- Al-Rawi, K. M., & Khalaf Allah, A. A. (1980). *Design and Analysis of Agricultural Experiments*. Ministry of Higher Education and Scientific Research, University of Mosul Press, Mosul, Iraq.
- Anna korus2010. Effect of the cultivar and harvest date of kale (*brassica oleracea l. var. acephala*) on crop yield and plant morphological features Kraków Agricultural University Department of Raw Materials and Processing of Fruit and Vegetables, Faculty of Food Technology Balicka 122, 30-149 Kraków, Polan.
- Anoenymous 2003a: Tarimsal Yapi ve Uretim. DIE Yayin No.2758 Ankara. Turkey.
- Cartea, M. E., Francisco, M., Soengas, P., & Velasco, P. (2011). Phenolic compounds in Brassica vegetables. Molecules, 16(1), 251-280.
- Qlaniyi , J. O. and A.E. Ojetayo. 2011. Effect of Fertilizer types on the growth and yield of two Cabbage Varieties. J. Ani. P. Sci. 12 (2): 1573 -1582.
- Rashid, M.A. and Mannan, M.A: Effect of planting time and spacing on the performance of cabbage. Bangladesh Hort. 17, 1983, 37-39.
- The Angiosperm Phylogeny, G. (2009): An update of Angiosperm Phylogeny Group classi fication for the orders and families of flowering plants: APG III. Botanical Journal of the Linnean Society, 161, 105-121.
- USDA, National Agricultural Statistics Service. 2012. Census of agriculture, accesed athttps://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/st99_1_038_038.pdf.