Growth and yield of potato (Solanum tuberosum L.) as affected by storage conditions and storage duration in Jos, Plateau State, Nigeria

Abstract: This study was carried out in two seasons (2010–2011 and 2012–2013) in Jos, Plateau State, Nigeria to investigate the growth and yield of potato (Solanum tuberosum L.) seed tubers as affected by storage conditions and storage duration. Five potato varieties (“Nicola,” “Bertita,” “Diamant,” “BR63-18,” and “Roslin-Ruaka”) were stored for three durations (12, 24, and 32 weeks) in three kinds of stores (room temperature store [RTS], diffused light store [DLS], and air-conditioned store [ACS]). The experimental design was a split–split plot in a randomized complete block design with the potato varieties, storage conditions, and storage durations as the main, sub, and sub–sub plots, respectively. All the parameters assessed varied with variety except the plant height. Germination and establishment were significantly higher in ACS than in RTS and DLS. RTS and DLS resulted in more aboveground stems than ACS. Storage in ACS resulted in a significantly higher plant height, leaf number, total number and yield of tubers, and yield of saleable tubers in both seasons. Seed tubers stored for 24 weeks resulted in the highest establishment count and the mean number of aboveground stems in both seasons. Aboveground stems increased from 12 to 24 weeks of storage and declined at 32 weeks. Seed storage for 12 weeks resulted in the highest total number of tubers, whereas 32 weeks had the lowest number of tubers in both seasons. Seed storage for 12 and 32 weeks resulted in the highest yield of tubers in seasons 1 and 2, respectively. In conclusion, potato varieties varied greatly in the rate of physiological aging; hence, every variety required specific storage conditions and duration for optimal growth and yield.

Keywords: potato, physiological age, field growth, yield

1 Introduction

The propagation material used to grow potato crop is the seed tuber. It is primarily propagated vegetatively via tubers although sexual propagation via botanical seed, called true potato seed, is also possible [1]. This vegetative propagation is the cheapest and easiest way of propagation even though it consists of a low multiplication rate [2]. One of the most important physiological factors associated with seed potato performance is physiological age [3,4]. Chronological and physiological age of seed tubers have major impacts on potato yield [5,6]. The essential yield components of potato crops are influenced by the physiological age of the tubers at planting [5,7].

Physiological age can be defined as the stage of development of a seed tuber, which changes progressively by increasing the chronological age and is modified by growth history and storage conditions [8–10]. Physiological age is the process of sprout development, and it depends on both the chronological age of the tubers and environmental conditions during growth in the field before storage and environmental conditions during storage. During its physiological development, the potato tuber passes through the stages of dormancy, apical dominance, multiple sprouting, and senility. During physiological aging, the tuber changes from physiologically young into physiologically old [11]. Physiologically young seed is characterized by one dominant bud that suppresses sprouting of the other buds on the tuber, a phenomenon in plants called apical dominance. In potato tubers, the result is a plant with fewer stems, fewer but larger tubers. Although physiologically older seed tubers are characterized by a loss of apical dominance, they produce multiple sprouts that emerge sooner. This means more stems, more tubers but the tubers are smaller [12].

The factors that affect the physiological aging of potato tubers have been reported to include growing conditions, storage conditions, the length of storage period, the temperature at which sprouts occur, light conditions,
the relative humidity, and competition between sprouts (the tuber size and the number of sprouts) [13]. Temperature and storage time (storage duration) have been reported to have a major influence on seed tuber physiological age [4,9,14]. Struiik and Wiersema [9] suggested seed storage as a way to manage physiological age. The warmer the storage temperatures, the older the seed will become physiologically. The pattern of sprout growth of a potato tuber depends on the physiological stage of the tuber. It has been reported that, in principle, the seed should be at least 3 months old before it is planted again and not older than 5–11 months (depending on the storage method and storage temperature) [15].

Physiological age of seed potatoes strongly affects emergence, the number of stems per plants, the number of tubers per stem, the tuber size distribution, and the tuber yield of the progeny crop [9,16–18]. Time to emergence in days after planting can be variable, and tubers of different physiological statuses may have a different lag period between planting and emergence [19]. One of the main traits defining the physiological status of the seed tuber and potato plant growth vigor is the number of stems per emerged plant. The number of stems is a crucial trait as it influences tuber number both per plant and per unit area [19].

Although physiologically young potato seeds have been reported to emerge later, have fewer stems per seed tuber, show later tuberization but less secondary growth, and have more foliage growth, more tubers per stem, and a later maturity [5,16] observed, the symptoms of advanced physiological age include more rapid plant emergence and establishment, reduced apical dominance (increased stems), increased tuber set per plant, and shift in tuber size distribution. The physiological age needs to be optimized to produce a canopy and a tuber system that allow tuber production for specific outlets (seed, fresh table potato, or processing potato) [20,21].

Nigerian farmers usually store freshly harvested tubers in any convenient space within the living room (common room in a home) or in any available space within the farmstead [22]. In many cases, such buildings are poorly ventilated and stored tubers are not sorted. This results in considerable loss of the tubers. Storage losses of up to 30% in only 2 months mainly to rots and loss of moisture had been reported [23]. The tubers, therefore, shrink, shrivel, and lose weight in storage. By far, one of the major problems, which will determine the future production possibilities of potato in Nigeria, is the ability to store the tubers after harvest whether it is seed or ware potato. Available storage facilities (for family farms and commercial scale production), especially for seed, must be improved and enlarged if increased future demand for potato must be met. If a solution can be found to this problem, then both the farmer and the consumer will be better off for it because the price of potato will be much less subject to fluctuations and a more stable supply could be expected in the market throughout the year. The storage conditions affect the physiological age of the seed tubers and one of the major factors that affect essential yield components of potato crop is the physiological age of the seed tuber at planting. The objective of this study was to determine the effects of storage method and storage duration on the field production of several common potato varieties in Nigeria.

2 Materials and methods

The study was conducted during 2010–2011 (season 1) and 2012–2013 (season 2) at the National Root Crops Research Institute (NRCRI) outstation, Kuru, Jos, Plateau State, Nigeria; 09°44′ N, 08°47′ E at an altitude 1,239 m above sea level to investigate the effects of storage method and storage duration on field production of some potato varieties in Nigeria.

Five potato cultivars, namely “Nicola,” “Bertita,” “BR63-18,” “Diamant,” and “Roslin-Ruaka,” were multiplied in the field and stored under three different storage conditions: “diffused light store (DLS),” “air-conditioned store (ACS; cooled store),” and “room temperature store (RTS; control)” for three storage durations (12, 24, and 32 weeks) and then taken to the field for planting. The storage conditions during the study have been reported by an earlier study [24]. The DLS used cool night air for cooling. The store consisted of air vents (inlet vents at the floor level and outlet vents on top of the walls opposite the inlet vents). The vents were opened at night and closed in the early hours of the morning to trap cool night air in the store. Plain and glazed glasses were fitted for illumination. The ACS was cooled with 1.5 hp split unit air conditioner and was artificially lit with low-energy bulbs. The RTS receives some light through the windows.

Storage temperature and relative humidity for each of the store types were recorded using a thermo-hygrometer (USB temperature and humidity data logger – CEM DT-172 model). Minimum and maximum temperatures for each day were calculated for each week and season (Figures 1 and 2, Appendix Tables 1 and 2).

During field evaluation, a split–split plot in a randomized complete block design was used with the potato varieties as the main plots, storage conditions as the sub plots, and storage durations as the sub-sub plots. There
were 45 treatment combinations, consisting of five potato varieties, three storage types, and three storage durations replicated three times.

As each storage duration (period) was attained (12, 24, and 32 weeks), the tubers were removed from the store and taken to appropriate plots in the field. Field growth measurements taken were included: emergence/establishment count (EC) was noted at 4 weeks after planting, whereas the plant height, the number of aboveground stems, and the number of leaves/plant were measured every 2 weeks. At harvest, the following measurements were made: the total number of tubers formed per plot converted to tuber yield per meter square, the number of marketable (40 and >40 mm) tubers per meter square, the number of seed (seed >35 mm) tubers per meter square, the total yield of marketable tubers (kg/m²), and the total yield of seed tubers (kg/m²).

The data collected were subjected to analysis of variance as in a split–split plot design, and the means were separated by least significant difference (LSD) at 0.05 significance level using the GENSTAT Discovery Edition 4 software (VSN International).

3 Results

3.1 EC

The main effects of variety, store type, and storage duration were all significant with respect to EC during the 2010–2011 planting (first season); however, during the 2012–2013 planting (second season), the main effect of store type was not significant (Table 1). Bertita, Nicola, and Roslin-Ruaka produced a significantly higher EC than BR63-18 and Diamant in the first season. However, in the second season, Roslin-Ruaka produced the highest EC (78.52%), whereas BR63-18 produced the lowest EC (64.12%; Table 1). Storage in ACS produced a significantly higher EC (83.56%) than storage in RTS and DLS in the
In both seasons, storage of tubers for 24 weeks resulted in the highest EC, whereas storage for 32 weeks produced a significantly lower EC (Table 1).

The interactions of variety × storage duration, variety × store type, and storage duration × store type significantly influenced EC ($P < 0.05$; Table 1).

### 3.2 Variety × store type interaction on the mean EC

During the first season, Nicola produced the highest EC (87.78%) in the RTS. In the DLS, all the varieties had similar EC. In the ACS, Nicola produced the lowest EC (66.67%). In the second season, all the varieties produced a similar EC in the RTS and DLS. However, in the ACS, Roslin-Ruaka produced the highest EC (87.78%; Table 2).

### 3.3 Variety × storage duration interaction on the mean EC

During season 1, at 12 weeks of storage (WOS), BR63-18 produced the highest EC, and at 24 WOS, Bertita produced 100% EC although it was similar to Nicola and Roslin-Ruaka. At 32 WOS, Nicola produced the highest EC (Table 3). During season 2, Nicola produced a significantly lower EC at 12 WOS, at 24 WOS, all the varieties produced a similar EC and at 32 WOS, Nicola produced the highest EC (Table 3).

#### Table 1: Effect of variety as affected by store type and storage duration on EC, the number of aboveground stems, the plant height, and the number of leaves during two seasons (2010–2011 and 2012–2013) in Jos

| Treatment | EC (%) | Aboveground stems | Plant height (cm) | Number of leaves |
|-----------|--------|-------------------|-------------------|-----------------|
|           | Season 1 | Season 2 | Season 1 | Season 2 | Season 1 | Season 2 | Season 1 | Season 2 | Season 1 | Season 2 | Season 1 | Season 2 |
| Variety   |         |          |          |          |          |          |          |          |          |          |          |          |
| Nicola    | 71.85a  | 73.33ab  | 6.44a    | 4.42b    | 28.58a   | 38.03c   | 67.87a   | 103.20   |
| Bertita   | 73.33a  | 68.89ab  | 4.88c    | 3.86bc   | 31.00a   | 50.67ab  | 50.51b   | 87.31    |
| Diamant   | 64.44b  | 72.59ab  | 6.21ab   | 4.42b    | 28.92a   | 46.85b   | 51.93b   | 111.09   |
| BR63-18   | 67.04b  | 64.12ab  | 5.10bc   | 3.20c    | 30.29a   | 35.45c   | 48.31b   | 64.30    |
| Roslin-Ruaka | 70.37a | 78.52a   | 6.15ab   | 5.02     | 24.57a   | 56.82a   | 48.19b   | 135.25   |
| LS        | *       | *        | **       | **       | NS       | **       | **       | **       |
| LSD0.05   | 9.99    | 9.51     | 1.41     | 0.51     | 6.94     | 7.66     | 7.77     | 20.22    |
| Storage type |        |          |          |          |          |          |          |          |
| RTS       | 64.44b  | 69.33a   | 5.45b    | 4.50a    | 22.71b   | 40.23c   | 44.81b   | 92.60    |
| DLS       | 60.22b  | 70.44a   | 3.52c    | 4.27a    | 17.43c   | 45.15b   | 31.64c   | 97.75    |
| ACS       | 83.56a  | 75.11a   | 8.30a    | 3.78b    | 45.94a   | 51.31a   | 83.86a   | 110.34   |
| LS        | **      | NS       | **       | **       | **       | **       | **       | **       |
| LSD0.05   | 7.74    | 7.38     | 0.70     | 0.39     | 1.99     | 3.46     | 6.48     | 14.06    |
| Storage duration (weeks) |        |          |          |          |          |          |          |          |
| 12        | 84.44a  | 73.11b   | 4.41c    | 4.14b    | 28.23b   | 37.72c   | 52.40b   | 73.80    |
| 24        | 87.56a  | 90.89a   | 7.27a    | 5.40a    | 24.03c   | 46.10b   | 43.27c   | 102.11   |
| 32        | 36.22b  | 50.89c   | 5.58b    | 3.01c    | 33.82a   | 52.88a   | 64.56a   | 124.78   |
| LS        | **      | **       | **       | **       | **       | **       | **       | **       |
| LSD0.05   | 7.74    | 7.38     | 0.75     | 0.44     | 2.83     | 4.38     | 6.37     | 15.39    |
| Interaction |        |          |          |          |          |          |          |          |
| Variety × storage duration | **      | **       | **       | **       | **       | **       | **       | **       |
| Variety × store type | **      | **       | **       | **       | **       | **       | **       | **       |
| Storage duration × store type | **      | **       | **       | **       | **       | **       | **       | **       |

LS, level of significance; *, significant; and ***, highly significant. Different letters in the same column indicate significant differences at $P < 0.05$; LSD, least significant difference; and NS, not significant at 5% probability level.
3.4 Store type × storage duration interaction on the mean EC

During both seasons, at 12 WOS, ACS produced a significantly lower EC than RTS and DLS. At 24 WOS, a similar EC was obtained for all the store types. At 32 WOS, ACS produced a significantly higher EC (83.33%) than RTS and DLS (Table 4).

3.5 The number of aboveground stems

The main effects of variety, store type, and storage duration on the number of aboveground stems were significant (P < 0.05) in both seasons (Table 1). Nicola and Roslin-Ruaka produced the highest stem number in seasons 1 and 2, respectively (Table 1). During season 1, ACS produced the highest stem number. However, in season 2, RTS and DLS produced a similar and significantly higher stem number than ACS. Tuber storage for 24 weeks produced the highest stem number in both seasons (Table 1). There was a significant interaction between variety × store type, variety × storage duration, and storage duration × store type (Table 1).

3.6 Variety × store type interaction on the mean stem number

During season 1, Nicola produced the highest stem number in RTS. In the DLS, all the varieties produced similar stem number, and in ACS, Roslin-Ruaka, BR63-18, and Diamant
produced a similar and significantly higher stem number than Nicola and Bertita (Table 2). In season 2, Roslin-Ruaka and Nicola produced the highest stem number in RTS. Roslin-Ruaka was the highest in DLS, whereas Diamant and Roslin-Ruaka produced the highest stem number in ACS (Table 2).

3.7 Variety × storage duration interaction on the mean stem number

In season 1, at 12 and 24 WOS, all the varieties produced a similar stem number but at 32 WOS, Nicola produced the highest stem number (Table 3). During season 2, at 12 WOS, all the varieties produced a similar stem number except BR63-18. At 24 WOS, Roslin-Ruaka and Diamant produced a significantly ($P < 0.05$) higher mean stem number. At 32 WOS, Nicola and Roslin-Ruaka produced the highest stem number (Table 3).

3.8 Store type × storage duration interaction on the mean stem number

In season 1, at 12 WOS, tubers stored in all the store types produced a similar stem number. At 24 WOS, tubers stored in RTS produced a significantly higher stem number (8.63). At 32 WOS, tubers stored in ACS produced the highest stem number (Table 4). During season 2, at 12 WOS, tubers stored in ACS produced a significantly lower stem number. The same pattern was repeated at 24 WOS, but at 32 WOS, tubers stored in ACS had the highest number (3.81; Table 4).
3.9 Plant height

All main effects were significant in the first and second seasons except the main effect of variety in the first season (Table 1). Roslin-Ruaka produced the tallest plants, whereas BR63-18 and Nicola produced the shortest plants in season 2. Storage in ACS produced the tallest plants in both seasons (Table 1). Storage of seed tubers for 32 weeks produced the tallest plants in both seasons (Table 1).

3.10 Variety × store type interaction on the mean plant height

During the first season, Nicola, BR63-18, and Bertita produced the tallest plants in RTS, DLS, and ACS, respectively (Table 2). During the second season, Roslin-Ruaka produced the tallest plants in RTS and DLS, whereas Diamant, Roslin-Ruaka, and Bertita produced similar and tallest plants in the ACS (Table 2).

3.11 Variety × storage duration interaction on the mean plant height

During season 1, at 12, 24, and 32 WOS, BR63-18, Bertita, and Nicola produced the tallest plants, respectively (Table 3). In season 2, at 12, 24, and 32 WOS, Diamant, Roslin-Ruaka, and Roslin-Ruaka produced the tallest plants (Table 3).

3.12 Store type × storage duration interaction on the mean plant height

In season 1, at 12 WOS, RTS produced the tallest plants. At 24 WOS, all the store types produced a similar plant height. At 32 WOS, ACS produced the tallest plants (Table 4). In season 2, at 12 and 24 WOS, all the store types produced a similar plant height; however, at 32 WOS, tubers stored in ACS produced the tallest plants (Table 4).

**Table 4: Interaction of store type and storage duration on the mean EC, the number of aboveground stems, the plant height, and the number of leaves during two seasons (2010–2011 and 2012–2013)**

| Treatment | Season 1 (2010–2011) | | Season 2 (2012–2013) | |
|-----------|----------------------|------------------|----------------------|------------------|
|           | Storage duration (weeks) | Storage duration (weeks) |                     |                     |
|           | 12 | 24 | 32 | 12 | 24 | 32 | 12 | 24 | 32 |
| Store type | | | | | | | | | |
| RTS | EC | 94.00a | 80.00a | 19.33b | 88.00a | 89.22a | 30.67b | 88.00a | 89.22a | 30.67b |
| DLS | EC | 87.33a | 89.33a | 4.00c | 81.33a | 91.33a | 38.67b | 81.33a | 91.33a | 38.67b |
| ACS | EC | 72.00b | 93.33a | 85.33a | 50.00b | 92.00a | 83.33a | 50.00b | 92.00a | 83.33a |
| LSD0.05 | | 13.41 | | | 12.78 | | | | |
| Number of aboveground stems | | | | | | | | | |
| RTS | 4.35a | 8.63a | 3.37b | 4.81a | 6.52a | 2.16c | 4.81a | 6.52a | 2.16c |
| DLS | 4.52a | 6.03b | — | 4.17a | 5.68b | 2.97b | 4.17a | 5.68b | 2.97b |
| ACS | 4.37a | 7.16b | 13.38a | 3.44b | 4.01c | 3.81a | 3.44b | 4.01c | 3.81a |
| LSD0.05 | | 1.25 | | | 0.72 | | | | |
| Plant height (cm) | | | | | | | | | |
| RTS | 31.68a | 22.82a | 13.63b | 35.87a | 45.27a | 39.66c | 35.87a | 45.27a | 39.66c |
| DLS | 28.96ab | 23.32a | — | 38.97a | 44.45a | 52.02b | 38.97a | 44.45a | 52.02b |
| ACS | 24.05b | 25.94a | 87.82a | 38.31a | 48.68a | 66.95a | 38.31a | 48.68a | 66.95a |
| LSD0.05 | | 4.42 | | | 6.99 | | | | |
| Number of leaves | | | | | | | | | |
| RTS | 67.80a | 48.50a | 43.50b | 77.70a | 61.50a | 128.10b | 77.70a | 61.50a | 128.10b |
| DLS | 67.40ab | 46.50a | — | 77.70a | 64.00a | 158.50b | 77.70a | 64.00a | 158.50b |
| ACS | 54.10b | 56.60a | 188.80a | 81.70a | 74.10a | 196.40a | 81.70a | 74.10a | 196.40a |
| LSD0.05 | | 13.52 | | | 35.87 | | | | |

Different letters in the same column indicate significant differences at $P < 0.05$; RTS, room temperature store; DLS, diffused light store; and ACS, air-conditioned store.
3.13 The number of leaves

All main effects were significant in both seasons (Table 1). Nicola and Roslin-Ruaka produced the highest number of leaves in seasons 1 and 2, respectively. Storage in ACS produced the highest number of leaves in both seasons. The 32 weeks storage treatments led to the highest number of leaves in both seasons (Table 1). There were significant interactions of variety \(\times\) store type, variety \(\times\) storage duration, and store type \(\times\) storage duration (Table 1).

3.14 Variety \(\times\) store type interaction on the mean number of leaves

In season 1, Nicola produced the highest number of leaves in the RTS. In the DLS, all the varieties produced a similar number of leaves. In the ACS, Diamant produced the highest number of leaves in season 2 (Table 2). During season 2, Roslin-Ruaka produced the highest number of leaves in the RTS. In the DLS and ACS, Roslin-Ruaka and Diamant produced similar numbers of leaves (Table 2).

3.15 Variety \(\times\) storage duration interaction on the mean number of leaves

During season 1, at 12, 24, and 32 WOS, BR63-18, Bertita, and Nicola produced the highest mean number of leaves, respectively (Table 3). In season 2, at 12 WOS, Diamant had the highest number of leaves. At 24 WOS, all the varieties produced a similar number of leaves, whereas at 32 WOS, Roslin-Ruaka produced the highest number of leaves (Table 3).

3.16 Storage duration \(\times\) store type interaction on the mean number of leaves

During season 1, at 12 WOS, RTS had the highest number of leaves. At 24 WOS, all the store types produced a similar number of leaves. At 32 WOS, ACS produced the highest number of leaves (Table 4). During season 2, at 12 and 24 WOS, all the store types produced a similar number of leaves. At 32 WOS, ACS produced the highest number of leaves (Table 4).

3.17 The total number of tubers formed

The main effects of variety, store type, and storage duration were all significant \((P < 0.05)\) with respect to the total number of tubers formed in season 1; however, in the second season, the main effect of store types was not significant (Table 5). All the varieties produced a similar number of tubers except Nicola, which was significantly higher at 18.68 tubers/m\(^2\) in season 1. In season 2, Nicola was the highest, whereas BR63-18 was the lowest. ACS produced the highest number of tubers \((16.63\) tubers/m\(^2\)). Tuber storage for 12 weeks produced the highest number of tubers in both seasons (Table 5). There were significant interactions of variety \(\times\) storage duration, variety \(\times\) storage type, and storage duration \(\times\) store type in season 1. Variety \(\times\) storage type interaction was not significant in season 2 (Table 5).

3.18 Variety \(\times\) store type interaction on the total number of tubers formed

During season 1, in the RTS Nicola produced a significantly higher tuber number than the other varieties that were similar. In the DLS, Nicola was the highest but similar to BR63-18 and Roslin-Ruaka. In the ACS, Nicola was the highest but similar to BR63-18 and Roslin-Ruaka (Table 6).

3.19 Variety \(\times\) storage duration interaction on the total number of tubers formed

During season 1, at 12, 24, and 32 WOS, BR63-18 and Nicola produced the highest number of tubers per meter square, respectively (Table 7). In season 2, Nicola produced the highest \((40.93\) tubers/m\(^2\)) after 12 WOS; after 24 WOS, Nicola, Bertita, and Roslin-Ruaka produced a similar number of tubers per meter square; and after 32 WOS, Nicola was the highest, whereas Bertita, Diamant and Roslin-Ruaka produced similar tubers per meter square (Table 7).

3.20 Store type \(\times\) storage duration interaction on the total number of tubers formed

During season 1, at 12 and 24 WOS, a similar number of tubers per meter square were produced for all the store types. At 32 WOS, ACS produced the highest number of tubers.
tubers per meter square (13.90), whereas RTS was the lowest. In season 2, Nicola and Bertita produced a similar number of tubers per meter square (Table 8).

### 3.2.1 The number of ware tubers formed

The main effects of variety, storage type, and storage duration were all significant ($P < 0.05$) with respect to the number of ware tubers formed in both seasons (Table 5). Bertita and Nicola produced the highest number of ware tubers in seasons 1 and 2, respectively. ACS produced the highest number of ware tuber of both seasons (Table 5). The 12 WOS produced the highest number of ware tubers in season 1, whereas 32 WOS produced the highest number of ware tubers in season 2. There were significant ($P < 0.05$) interactions of variety × store type, variety × storage duration, and storage duration × store type (Table 5).

### 3.2.2 Variety × store type interaction on the number of ware tubers formed

During season 1, Bertita produced the highest number of ware tubers (3.03 tubers/m$^2$), whereas all the other varieties were similar in the RTS. With DLS, Bertita was the highest (2.48 tubers/m$^2$), whereas Diamant was the lowest. With ACS, Nicola, Bertita, and Roslin-Ruaka had a similar...
and the highest number of ware tubers (Table 6). In season 2, Nicola produced the highest number of ware tubers, whereas the other varieties were similar in the RTS and DLS, respectively. With the ACS, Nicola and Diamant produced a similar and higher number of ware tubers, whereas BR63-18 was the lowest (Table 6).

### 3.23 Variety × storage duration interaction on the number of ware tubers formed

During season 1, at 12 and 24 WOS, Bertita produced the highest number of ware tubers. At 32 WOS, Nicola

### Table 6: Interaction of variety and store type on the total number of tubers, the number of ware tubers, the number of seed tubers, the total yield of tubers, the yield of ware tubers, and the yield of seed tubers during two seasons (2010–2011 and 2012–2013)

| Treatment | Season 1 (2010–2011) | Season 2 (2012–2013) |
|-----------|-----------------------|-----------------------|
|           | RTS | DLS | ACS | RTS | DLS | ACS | RTS | DLS | ACS |
| Variety   |     |     |     |     |     |     |     |     |     |
| Nicola    | 23.60a | 13.57a | 18.90a | 5.48a | 7.52a | 11.40a |
| Bertita   | 10.87b | 10.27b | 13.53c | 3.33b | 4.30b | 8.04b |
| Diamant   | 11.30b | 10.03b | 15.00c | 1.63b | 2.30b | 10.19a |
| BR63-18   | 9.60b | 12.90ab | 18.70a | 2.33b | 2.33b | 4.59c |
| Roslin-Ruaka | 9.10b | 10.80ab | 17.03ab | 2.41 | 4.56b | 8.44b |
| LSD₀.₀₅   | 3.18 |     |     | 2.79 |     |     |
| Number of ware tubers per meter square |     |     |     |     |     |     |
| Nicola    | 0.96b | 0.85bc | 3.30a | 5.48a | 7.52a | 11.40a |
| Bertita   | 3.30a | 2.48a | 3.22a | 3.33b | 4.30b | 8.04b |
| Diamant   | 1.11b | 0.70c | 2.19b | 1.63b | 2.30b | 10.19a |
| BR63-18   | 0.56b | 0.85bc | 2.81ab | 2.33b | 2.33b | 4.59c |
| Roslin-Ruaka | 1.11b | 1.48b | 3.22a | 2.41 | 4.56b | 8.44b |
| LSD₀.₀₅   | 0.66 |     |     | 2.79 |     |     |
| Number of seed tubers per meter square |     |     |     |     |     |     |
| Nicola    | 22.63a | 12.70a | 15.60a | 38.14a | 27.37a | 23.96a |
| Bertita   | 7.57b | 7.77c | 10.30b | 7.22d | 11.26c | 11.19c |
| Diamant   | 10.20b | 9.33bc | 13.20ab | 19.00bc | 19.33b | 21.48ab |
| BR63-18   | 9.43b | 12.03ab | 15.90a | 15.37c | 17.00bc | 15.67bc |
| Roslin-Ruaka | 8.00b | 9.23bc | 14.00a | 24.15b | 20.11ab | 19.44ab |
| LSD₀.₀₅   | 3.16 |     |     | 7.69 |     |     |
| Total yield of tubers (kg/m²) |     |     |     |     |     |     |
| Nicola    | 0.31b | 0.20b | 0.39a | 0.63a | 0.69a | 0.90ab |
| Bertita   | 0.42a | 0.32a | 0.46a | 0.37b | 0.53ab | 1.08a |
| Diamant   | 0.26bc | 0.19b | 0.27b | 0.28b | 0.35b | 0.90ab |
| BR63-18   | 0.18c | 0.25ab | 0.38a | 0.20b | 0.32b | 0.46c |
| Roslin-Ruaka | 0.22c | 0.75ab | 0.38a | 0.39ab | 0.48ab | 0.83b |
| LSD₀.₀₅   | 0.08 |     |     | 0.25 |     |     |
| Yield of ware tubers (kg/m²) |     |     |     |     |     |     |
| Nicola    | 0.05b | 0.04b | 0.19b | 0.30a | 0.43a | 0.71b |
| Bertita   | 0.21a | 0.19a | 0.29a | 0.28ab | 0.40a | 0.93a |
| Diamant   | 0.08b | 0.03b | 0.11c | 0.10bc | 0.16b | 0.61b |
| BR63-18   | 0.03b | 0.06b | 0.18b | 0.07b | 0.14b | 0.31c |
| Roslin-Ruaka | 0.07b | 0.07b | 0.19b | 0.16bc | 0.27ab | 0.61b |
| LSD₀.₀₅   | 0.06 |     |     | 0.20 |     |     |
| Yield of seed tubers (kg/m²) |     |     |     |     |     |     |
| Nicola    | 0.25a | 0.16a | 0.21a | 0.33a | 0.22a | 0.19a |
| Bertita   | 0.13b | 0.13b | 0.16a | 0.08c | 0.13a | 0.16a |
| Diamant   | 0.18b | 0.16ab | 0.15a | 0.18bc | 0.19a | 0.29a |
| BR63-18   | 0.15b | 0.19a | 0.20a | 0.32a | 0.18a | 0.16a |
| Roslin-Ruaka | 0.15b | 0.15ab | 0.20a | 0.23bc | 0.22a | 0.19a |
| LSD₀.₀₅   | 0.06 |     |     | 0.15 |     |     |

Different letters in the same column indicate significant differences at P < 0.05.
produced the highest (Table 7). In season 2, all the varieties produced a similar number of ware tubers except Nicola, which was significantly lower after 12 WOS. At 24 WOS, all the varieties produced a similar number of ware tubers, and at 32 WOS, Nicola was the highest, whereas BR63-18 was the lowest (Table 7).

### Table 7: Interaction of variety and storage duration on the total number of tubers, the number of ware tubers, the number of seed tubers, the total yield of tubers, the yield of ware tubers, and the yield of seed tubers during two seasons (2010–2011 and 2012–2013)

| Treatment | Season 1 (2010–2011) |  | Season 2 (2012–2013) |  |
|-----------|----------------------|----------------------|----------------------|----------------------|
|           | Storage duration (weeks) | 12 | 24 | 32 | Storage duration (weeks) | 12 | 24 | 32 |
| Variety   | Total number of tubers per meter square |  |  |  | Number of ware tubers per meter square |  |  |  |
| Nicola    | 25.37b | 14.40a | 16.27a | 40.93a | 27.37a | 45.63a |
| Bertita   | 20.30c | 11.43ab | 2.90b | 16.87c | 9.90b | 18.30b |
| Diamant   | 21.97bc | 8.87bc | 5.53b | 28.97b | 25.90a | 19.07b |
| BR63-18   | 30.03a | 6.70c | 4.43b | 31.47b | 14.87b | 9.63c |
| Roslin-Ruaka | 22.07bc | 11.19ab | 5.04b | 29.87b | 27.93a | 22.67b |
| LSD0.05   | 3.78 | 8.18 |  |  |  |
|           | Number of ware tubers per meter square |  |  |  | Number of seed tubers per meter square |  |  |  |
| Nicola    | 1.89c | 1.11bc | 2.11a | 2.63b | 3.11a | 18.67a |
| Bertita   | 6.37a | 1.63a | 1.00b | 6.29a | 2.30a | 7.07b |
| Diamant   | 2.07bc | 0.67c | 1.26b | 5.15a | 1.07a | 7.89b |
| BR63-18   | 1.78c | 0.85bc | 1.59ab | 4.11a | 2.67a | 2.48c |
| Roslin-Ruaka | 2.63b | 1.48b | 1.70ab | 4.22a | 1.59a | 9.59b |
| LSD0.05   | 0.72 | 3.20 |  |  |  |
|           | Total yield of tubers (kg/m²) |  |  |  | Yield of ware tubers (kg/m²) |  |  |  |
| Nicola    | 0.48c | 0.19a | 0.23a | 0.56ab | 0.28a | 1.39a |
| Bertita   | 0.84a | 0.24a | 0.11b | 0.76a | 0.24a | 0.97b |
| Diamant   | 0.53bc | 0.09b | 0.10b | 0.68ab | 0.17a | 0.67b |
| BR63-18   | 0.57b | 0.11b | 0.14b | 0.38b | 0.28a | 0.23c |
| Roslin-Ruaka | 0.57b | 0.17a | 0.12b | 0.56ab | 0.21a | 0.93b |
| LSD0.05   | 0.08 | 0.23 |  |  |  |
|           | Yield of seed tubers (kg/m²) |  |  |  |  |
| Nicola    | 0.11b | 0.04a | 0.13a | 0.17b | 0.16a | 1.13a |
| Bertita   | 0.50a | 0.09a | 0.10a | 0.60a | 0.19a | 0.83ab |
| Diamant   | 0.13b | 0.02a | 0.07a | 0.35b | 0.05a | 0.47c |
| BR63-18   | 0.11b | 0.05a | 0.10a | 0.19b | 0.18a | 0.15d |
| Roslin-Ruaka | 0.16b | 0.07a | 0.10a | 0.26b | 0.08a | 0.69b |
| LSD0.05   | 0.07 | 0.22 |  |  |  |
|           | Yield of seed tubers (kg/m²) |  |  |  |  |
| Nicola    | 0.37b | 0.15a | 0.10a | 0.34ab | 0.14a | 0.26a |
| Bertita   | 0.26c | 0.15a | 0.02b | 0.16c | 0.06a | 0.14a |
| Diamant   | 0.40b | 0.07b | 0.03b | 0.33ab | 0.12a | 0.20a |
| BR63-18   | 0.46a | 0.06b | 0.03b | 0.48a | 0.10a | 0.07b |
| Roslin-Ruaka | 0.37b | 0.11ab | 0.02b | 0.30bc | 0.13a | 0.21a |
| LSD0.05   | 0.05 | 0.16 |  |  |  |

Different letters in the same column indicate significant differences at $P < 0.05$.

### 3.24 Storage type × storage duration interaction on the number of ware tubers formed

During season 1, at 12 and 24 WOS, all the store types produced a similar number of ware tubers per meter.
square. At 32 WOS, ACS produced the highest number of ware tubers per meter square (Table 8).

### 3.25 The number of seed tubers

The main effects of variety, store type, and storage duration were all significant \((P < 0.05)\) with respect to the mean number of seed tubers in the first season; however, in the second season, the main effect of store type was not significant (Table 5). Nicola produced the highest number of seed tubers in both seasons. ACS produced the highest number of seed tubers in season 1. Storage of tubers for 12 weeks produced the highest number of seed tubers in both seasons. All interactions were significant with respect to the number of seed tubers produced (Table 5).

### 3.26 Variety × store type interaction on the number of seed tubers

During the first season, Nicola produced the highest number of seed tubers, whereas all other varieties were similar in the RTS. With the DLS, Nicola was significantly higher than Bertita. With ACS, Nicola, BR63-18, and Roslin-Ruaka produced a similar and the highest number of seed tubers (Table 6). In season 2, Nicola produced the
highest number of seed tubers in all the store types, whereas the other varieties were significantly different (Table 6).

3.27 Variety × storage duration interaction on the number of seed tubers

During season 1, at 12 WOS, BR63-18 produced the highest number of seed tuber per meter square. At 24 WOS, Nicola was the highest (13.0 tubers/m²). At 32 WOS, Nicola produced the highest number of seed tubers, whereas all the other varieties were similar (Table 7).

In season 2, at 12 WOS, although Nicola was the highest, Bertita produced the lowest number of seed tubers per meter square. At 24 WOS, Nicola, Diamant, and Roslin-Ruaka produced a similar and the highest number of seed tubers. At 32 WOS, Nicola was the highest, whereas all other varieties produced a similar number of seed tubers per meter square (Table 7).

3.28 Storage duration × store type interaction on the number of seed tubers

During season 1, at 12 and 24 WOS, all the store types produced a similar number of seed tubers. At 32 WOS, ACS produced the highest number of seed tubers per meter square (Table 8). During season 2 at 12 WOS, ACS produced a significantly lower number of seed tubers than the other store types. At 24 WOS, RTS was the highest, whereas at 32 WOS, ACS produced the highest number of seed tubers per meter square (Table 8).

3.29 The total yield of tubers

All main effects with respect to the total yield of tubers were significant ($P < 0.05$; Table 5). Variety Betita resulted in the highest yield of 0.40 kg/m² in season 1, whereas Nicola had the highest yield of 0.74 kg/m² in season 2. Storage in ACS produced the highest yield of 0.38 kg/m², whereas DLS and RTS were similar in season 1. In season 2, ACS was the highest, whereas RTS had a significantly lower yield. Storage for 12 weeks produced the highest yield of 0.60 kg/m² in season 1. In season 2, 32 WOS produced the highest yield of 0.84 kg/m². All interactions were significant (Table 5).

3.30 Variety × store type interaction on the total yield of tubers

In the first season, Bertita produced the highest total yield of tubers (0.42 kg/m²) in the RTS. In the DLS, Bertita was the highest. In the ACS, Nicola, Bertita, BR63-18, and Roslin-Ruaka produced the highest yield, whereas Diamant was significantly lower (Table 6). In season 2, Nicola and Bertita produced the highest total yield of tubers in the RTS. In the DLS, Nicola, Bertita and Roslin-Ruaka had the highest total yield of tubers. In ACS, Bertita produced the highest total yield of tubers per meter square (Table 6).

3.31 Variety × storage duration interaction on the total yield of tubers

During season 1, at 12 WOS Bertita produced the highest total yield of tubers. At 24 WOS, Nicola, Bertita, and Roslin-Ruaka had a similar and the highest total yield of tubers. At 32 WOS, Nicola had the highest total yield of tubers, whereas all other varieties were similar (Table 7). In season 2, Bertita had the highest total yield of tubers at 12 WOS, and at 24 WOS, all the varieties produced a similar total yield of tubers per meter square (Table 7). At 32 WOS, Nicola had the highest total yield of tubers (Table 7).

3.32 Storage duration × store type interaction on the total yield of tubers

During season 1, at 12 WOS RTS produced the highest total yield of 0.64 kg/m². At 24 and 32 WOS, ACS produced the highest total yield of tubers (Table 8). In season 2, at 12 WOS, RTS and DLS produced a similar and the highest total yield of tubers per meter square. At 24 WOS, all the store types had a similar total yield of tubers (Table 8).

3.33 Yield of ware tubers

All main effects with respect to yield of ware tubers were significant ($P < 0.05$; Table 5). Bertita had the highest yield of ware tubers (0.23 kg/m²) in season 1. In season 2, Bertita and Nicola had a similar and the highest yield of ware tubers. ACS resulted in the highest yield of ware tubers in both seasons (Table 5). In season 1, 12 WOS
produced the highest yield of ware tubers; however, in season 2, 32 WOS produced the highest yield of ware tubers. Interactions of variety × store type, variety × storage duration, and storage duration × store type were all significant (Table 5).

3.34 Variety × store type interaction on the yield of ware tubers

During season 1, Bertita produced the highest yield of ware tubers in RTS and DLS, whereas all other varieties were similar. In ACS, Bertita was the highest, whereas Diamant was the lowest in yield of ware tubers (Table 6). In season 2, Nicola and Bertita had the highest yield of ware tubers in the RTS and DLS. In the ACS, Bertita had the highest yield of ware tubers (Table 6).

3.35 Variety × storage duration interaction on the yield of ware tubers

During season 1, Bertita had the highest yield of ware tubers at 12 WOS. At 24 and 32 WOS, all the varieties had a similar yield of ware tubers (Table 7). In season 2, Bertita was the highest at 12 WOS. At 32 WOS, Nicola produced the highest yield (Table 7).

3.36 Storage duration × storage type interaction on the yield of ware tubers

During season 1, at 12 and 24 WOS, all the store types produced a similar yield of ware tubers (Table 8). In season 2, at 12 WOS, ACS produced a significantly lower yield of ware tubers. At 24 WOS, all the store types had a similar yield of ware tubers; however, at 32 WOS, ACS produced the highest yield of ware tuber (Table 8).

3.37 Yield of seed tubers

The main effects of variety and storage duration on the yield of seed tubers were significant in both seasons, whereas the main effect of store type was not significant ($P < 0.05$; Table 5). Variety Bertita produced a significantly lower yield of seed tubers in both seasons. Tuber storage for 12 weeks produced the highest yield of seed tubers per meter square (Table 5).

3.38 Variety × store type interaction on the yield of seed tubers

During season 1, Nicola produced a significantly higher yield of seed tubers than the other varieties that were similar in the RTS. In the DLS, Bertita produced the lowest yield of seed tubers. In the ACS, all the varieties produced a similar yield of seed tubers (Table 6).

In season 2, Nicola and BR63-18 produced the highest yield of seed tubers in the RTS. In the DLS and ACS, all the varieties produced a similar yield of seed tubers (Table 6).

3.39 Variety × storage duration interaction on the yield of seed tubers

During season 1, at 12 WOS, BR63-18 produced the highest yield of seed tubers. At 24 WOS, Nicola, Bertita, and Roslin-Ruaka had the highest yield of seed tubers. At 32 WOS, Nicola produced a significantly higher yield of seed tubers than the other varieties (Table 7).

In season 2, BR63-18 had the highest yield of seed tubers at 12 WOS. At 24 WOS, all the varieties had a similar yield of seed tubers, and at 32 WOS, BR63-18 produced a significantly lower yield of seed tubers (Table 7).

3.40 Store type × storage duration interaction on the yield of seed tubers

During season 2, at 12 WOS, ACS produced a significantly lower yield of seed tubers than the other store types. At 24 WOS all the store types had similar yield of seed tubers. At 32 WOS, ACS had the highest yield of seed tubers (Table 8).

4 Discussion

EC was generally significantly different with variety. The varietal variations may be attributed to the genetic composition of the varieties and environmental conditions;
for example, soil temperature and soil moisture during growth in the field, which also differed between storage types. It has been observed that emergence depends on physiological age of seed tubers, planting date, soil temperature, other environmental factors, and the characteristics of a particular cultivar [25]. EC varied significantly with store type and storage duration in seasons 1 and 2. RTS and DLS were characterized by a higher storage temperature than the ACS and a higher EC after 12 weeks of seed tuber storage. Physiological age has been reported to affect tuber germination and date of emergence [4].

Generally, the main effects of variety, storage duration, and store type on the mean number of aboveground stems were significant in both seasons. The variation in stem number as affected by variety could be a cultivar characteristic. Stem number has been found to be significantly affected by cultivar [2]. Mediouni et al. [4] observed that cultivar influences not only the sprouting process of tubers but also the vegetative growth and the productivity of the resulting plants. Variation in the stem number with store type may be attributed to environmental conditions in the store types especially temperature, chronological, and physiological age of the tubers. Van Loon [26] and Moll [27] reported that physiological age affected seed tubers’ future crop performance from emergence to the number of emerged stems per mother tuber. Physiological quality of seed tubers has been reported to affect the quality of sprouts as well as the number of stems per plant and, therefore, the yield [4].

The difference in the plant height due to variety may be attributed to the genetic composition of the varieties. Cultivar differences in the plant height has been reported [2,28]. The plant height varied significantly ($P < 0.05$) with storage duration and store type. Vakis [29] and Moll [27] reported that physiological age of seed tubers affects future crop performance from emergence to crop vigor and growth. Mediouni et al. [4] reported that physiologically older tubers produce less vine growth.

Generally in both seasons, the main effect of variety on the number of leaves formed per plant was significant ($P < 0.05$). Varietal differences in the distribution of leaves above ground and stolon below ground have been reported [30]. Iritani [31] reported that the plants from older seed tubers had a significantly smaller foliage and considerably less vigor than seeds from young seed. It has been found that the progress from physiologically young to physiologically old affects canopy growth pattern of potato [32].

Generally, the main effect of variety on the total number of tubers formed was significant in all seasons. Nicola resulted in the highest number of tubers formed, whereas Bertita resulted in the lowest number of tubers formed in all seasons. The variation may be attributed to the genetic composition of the varieties used and environmental conditions during crop growth in the field. The number of tubers produced in a potato crop has been reported to be affected by stem population, variety, and environmental factors such as temperature, moisture, and nutrients supply [33]. The number of tubers formed has been reported to be significantly affected by variety [2,34].

The final total number of tubers formed varied with store type and storage duration. The interaction may be attributed to environmental conditions, especially temperature in the store types, physiological age of the seed tubers, and environmental conditions during crop growth in the field. Gao et al. [35] reported that during tuber initiation stage, tubers are formed on stolon, and the number of tubers carried to harvest is determined by environmental conditions during this growing stage. Growing season has been reported to have a carryover effect on the number of daughter tubers produced per seed potato [36,37].

The main effect of variety on final total yield of tubers was significant ($P < 0.05$). The tuber yield has been reported to be significantly influenced by variety for all tuber size and quality categories [38].

The final total tuber yield varied significantly with store type and storage duration. After 12 weeks of seed tuber storage, seed tubers stored in ACS resulted in the lowest yield of tubers than the RTS and DLS in all the seasons. After 32 weeks of seed tuber storage, seed tubers stored in ACS resulted in the highest yield of tubers in both season. At final harvest, the tuber yield has been reported to be higher in physiologically young seed than older ones [9,39]. The number of ware tubers formed varied significantly with variety in all the seasons. This variation may be due to genetic makeup of the varieties. The tuber yield has been reported to be significantly influenced by variety for all tuber size categories [38]. Struik et al. [21] reported that tuber size distribution is mainly dependent on the yield (i.e., a change of the average tuber size). The number of ware tubers formed varied with store type and storage duration in all the seasons.

The yield of ware tubers was significantly ($P < 0.05$) affected by variety in all the seasons. This variation may be due to genetic composition of the varieties. The yield has been reported to be significantly influenced by variety for all sizes and quality categories [38].

The yield of ware tubers varied significantly with store type and storage duration in all the seasons. After 12 and 24 weeks of seed tuber storage, all the store types...
resulted in a similar yield of ware tubers in both seasons. After 32 weeks of seed tuber storage, the ACS resulted in a significantly higher yield of ware tubers in both seasons. This interaction may be attributed to environmental conditions especially temperature, physiological age of seed tubers, and environmental conditions during crop growth in the field. Tuber growth has been reported to be higher at the end of the growing season in those plants coming from physiologically young seed tubers [39]. Toosey [40] and Iritani [31] reported that as tubers aged physiologically, the plants have less potential for higher yield than plants that form physiologically young seed. Bohl et al. [41] observed that physiologically older seeds will result in reduction in plant stand, vigor, and yield. This suggests reasons why seed tubers from ACS resulted in higher yield after 32 weeks of seed tuber storage.

The final yield of seed tubers formed varied significantly with variety in all the seasons. The variation may be as a result of genetic composition of the varieties and changes in environmental conditions from season to season. Mannaf et al. [42] found that seed tuber yield varied with variety. Variety Dheera had a seed yield of 17.65 t/ha, whereas variety Iteera had a seed yield of 17.27 t/ha.

Physiological age had marked effect on the growth and yield of potato in the field.

Acknowledgments: Prof. O.P. Ifenkwe – design and revising of manuscript, Prof. B.A. Kalu – research supervisor, Dr Charles Amadi – field supervisor, Dr Daniel Lenka – field supervisor, Dr I.J. Dantata – data analysis, Dorcas Bello – research assistant, NRCRI, Potato Programme Kuru, Jos – provision of experimental site.

Funding information: The authors state no funding involved.

Author contributions: K.E.D. – design, performance, and reporting, M.O.O. – research supervisor, N.I.O. – research supervisor.

Conflict of interest: The authors state no conflict of interest.

Data availability statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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## Table 1: Weekly temperature and relative humidity in ACS, DLS, and RTS during the 2010 (Sep–Dec) to 2011 (Jan–May) season in Jos

| Year | Month/date | ACS Temperature (°C) | RH % | DLS Temperature (°C) | RH % | RTS Temperature (°C) | RH % |
|------|------------|----------------------|------|----------------------|------|----------------------|------|
|      |            | Min                  | Max  | Min                  | Max  | Min                  | Max  |
| 2010 | 09/04      | 16.14                | 16.74| 19.91                | 21.00| 20.40                | 23.07| 89.32 |
|       | 09/11      | 15.46                | 15.59| 20.17                | 21.93| 22.14                | 25.70| 82.94 |
|       | 09/19      | 15.53                | 15.94| 20.40                | 22.13| 22.21                | 26.39| 77.47 |
|       | 09/26      | 15.44                | 15.61| 20.17                | 22.84| 21.87                | 26.09| 71.81 |
|       | 10/03      | 15.31                | 16.13| 20.54                | 22.90| 22.70                | 25.86| 69.99 |
|       | 10/10      | 15.53                | 16.74| 22.81                | 22.66| 21.27                | 24.29| 79.31 |
|       | 10/17      | 15.61                | 16.23| 21.46                | 22.06| 20.56                | 23.19| 89.93 |
|       | 10/24      | 15.50                | 16.13| 22.10                | 21.84| 20.06                | 23.79| 89.69 |
|       | 10/31      | 15.27                | 15.63| 21.06                | 21.84| 19.99                | 23.34| 84.33 |
|       | 11/07      | 15.33                | 15.77| 20.29                | 22.46| 20.43                | 23.76| 75.86 |
|       | 11/14      | 15.67                | 17.77| 20.59                | 23.66| 21.43                | 25.33| 71.64 |
|       | 11/21      | 15.49                | 21.46| 19.64                | 23.04| 20.99                | 23.91| 61.14 |
|       | 11/28      | 15.37                | 20.56| 19.37                | 22.99| 20.47                | 24.74| 51.56 |
|       | 12/05      | 15.37                | 21.27| 19.40                | 23.07| 20.46                | 24.71| 45.97 |
|       | 12/12      | 15.09                | 19.67| 17.91                | 20.76| 17.90                | 23.07| 42.26 |
|       | 12/19      | 15.11                | 21.17| 18.04                | 22.29| 19.36                | 23.47| 40.51 |
|       | 12/26      | 15.01                | 18.83| 17.47                | 21.40| 18.30                | 23.30| 35.69 |
| 2011 | 01/02      | 15.06                | 18.26| 16.56                | 20.33| 17.30                | 21.84| 39.31 |
|       | 01/09      | 15.13                | 18.36| 16.86                | 19.81| 17.07                | 22.33| 36.69 |
|       | 01/16      | 15.39                | 18.90| 15.14                | 19.39| 15.70                | 21.76| 33.44 |
|       | 01/23      | 14.20                | 18.89| 15.14                | 19.74| 16.14                | 20.97| 36.66 |
|       | 01/30      | 16.00                | 22.19| 18.66                | 23.31| 20.03                | 25.23| 26.80 |
|       | 02/06      | 16.60                | 24.19| 21.53                | 24.69| 22.20                | 27.21| 38.24 |
|       | 02/13      | 15.64                | 22.19| 21.04                | 23.94| 21.27                | 25.70| 35.37 |
|       | 02/20      | 15.59                | 22.99| 22.90                | 25.49| 22.49                | 27.24| 41.53 |
|       | 02/27      | 15.51                | 18.76| 23.11                | 24.39| 23.16                | 27.30| 39.74 |
|       | 03/06      | 15.86                | 21.91| 21.79                | 25.30| 23.09                | 26.39| 33.47 |
|       | 03/13      | 16.24                | 22.96| 23.31                | 26.71| 24.01                | 28.99| 23.56 |
|       | 03/20      | 16.61                | 22.06| 22.40                | 25.91| 23.64                | 28.69| 27.16 |
|       | 03/27      | 15.93                | 22.97| 24.93                | 26.73| 24.63                | 28.63| 37.33 |
|       | 04/03      | 16.20                | 22.63| 23.04                | 27.11| 24.37                | 28.54| 26.54 |
|       | 04/10      | 16.36                | 22.80| 24.37                | 26.37| 23.73                | 28.31| 21.49 |
|       | 04/17      | 16.34                | 23.10| 25.20                | 28.04| 25.24                | 29.04| 41.73 |
|       | 04/24      | 16.19                | 23.97| 28.09                | 27.69| 25.29                | 31.57| 59.27 |
|       | 05/01      | 15.97                | 18.39| 27.19                | 23.34| 21.27                | 29.99| 74.63 |
|       | 05/08      | 15.47                | 19.99| 26.16                | 23.99| 22.14                | 29.44| 78.79 |
|       | 05/15      | 15.70                | 19.91| 25.60                | 23.29| 21.10                | 29.14| 79.36 |
|       | 05/22      | 16.30                | 20.60| 26.20                | 24.24| 22.53                | 29.50| 78.84 |
|       | 05/29      | 16.80                | 20.76| 25.39                | 22.00| 20.69                | 28.47| 84.16 |

ACS, air-conditioned store; RTS, room temperature store; DLS, diffused light store; RH, relative humidity; min, minimum; and max, maximum.
Table 2: Weekly maximum and minimum air temperature and relative humidity in various potato stores in 2012 (Sep–Dec) to 2013 (Jan–May) season

| Year | Month/date | ACS | DLS | RTS |
|------|------------|-----|-----|-----|
|      |            | Temperature (°C) | RH | Temperature (°C) | RH | Temperature (°C) | RH |
|      |            | Min | Max | %   | Min | Max | %   | Min | Max | %   |
| 2012 | 09/16      | 17.10 | 20.76 | 98.03 | 20.56 | 23.26 | 87.67 | 19.67 | 21.49 | 94.61 |
|      | 09/23      | 15.11 | 19.16 | 97.39 | 19.07 | 20.33 | 94.33 | 21.07 | 23.06 | 91.47 |
|      | 09/30      | 14.26 | 16.89 | 95.86 | 20.10 | 21.56 | 92.24 | 21.16 | 23.71 | 88.17 |
|      | 10/07      | 14.00 | 16.50 | 93.06 | 21.01 | 22.61 | 89.86 | 21.16 | 23.71 | 88.17 |
|      | 10/14      | 13.94 | 16.73 | 90.14 | 20.97 | 22.86 | 87.73 | 22.00 | 24.24 | 84.20 |
|      | 10/21      | 14.21 | 17.11 | 86.29 | 21.74 | 23.13 | 85.61 | 22.17 | 24.26 | 83.80 |
|      | 10/28      | 14.74 | 16.79 | 87.61 | 21.57 | 22.76 | 85.27 | 21.53 | 23.80 | 81.51 |
|      | 11/04      | 14.59 | 18.41 | 83.67 | 21.53 | 22.99 | 82.90 | 22.84 | 25.40 | 75.57 |
|      | 11/11      | 14.94 | 19.61 | 75.60 | 21.93 | 23.67 | 74.31 | 22.37 | 25.04 | 65.94 |
|      | 11/18      | 14.93 | 18.00 | 65.73 | 21.44 | 23.43 | 54.10 | 21.71 | 26.11 | 55.24 |
|      | 11/25      | 15.49 | 18.00 | 67.24 | 21.96 | 24.26 | 48.94 | 23.31 | 26.31 | 50.86 |
|      | 12/02      | 15.76 | 20.66 | 63.44 | 22.01 | 23.94 | 38.16 | 22.79 | 25.99 | 47.54 |
|      | 12/09      | 16.86 | 21.56 | 60.63 | 21.83 | 23.84 | 43.36 | 23.13 | 26.26 | 44.40 |
|      | 12/16      | 16.54 | 19.16 | 52.10 | 21.56 | 23.53 | 39.91 | 21.41 | 24.97 | 33.64 |
|      | 12/23      | 16.33 | 20.59 | 39.51 | 19.99 | 22.10 | 27.89 | 20.01 | 23.74 | 31.60 |
|      | 12/30      | 14.67 | 17.97 | 44.59 | 18.69 | 21.01 | 28.09 | 19.37 | 23.20 | 32.30 |
| 2013 | 01/06      | 15.01 | 18.71 | 45.50 | 17.69 | 20.16 | 28.51 | 19.66 | 23.61 | 35.19 |
|      | 01/13      | 15.44 | 19.14 | 46.36 | 18.79 | 21.26 | 33.50 | 19.06 | 23.29 | 33.97 |
|      | 01/20      | 15.43 | 18.19 | 50.87 | 18.64 | 21.54 | 29.67 | 22.66 | 25.93 | 37.27 |
|      | 01/27      | 15.93 | 22.41 | 58.93 | 22.16 | 24.06 | 40.54 | 24.34 | 27.01 | 41.83 |
|      | 02/03      | 14.96 | 19.01 | 41.66 | 22.30 | 23.99 | 46.23 | 19.71 | 23.37 | 32.84 |
|      | 02/10      | 15.64 | 18.39 | 44.94 | 18.57 | 21.11 | 32.66 | 22.09 | 25.71 | 28.14 |
|      | 02/17      | 15.80 | 19.64 | 44.33 | 21.21 | 24.09 | 21.40 | 24.03 | 27.23 | 26.50 |
|      | 02/24      | 16.46 | 20.24 | 44.00 | 22.43 | 25.20 | 22.31 | 24.99 | 28.43 | 25.60 |
|      | 03/03      | 17.44 | 23.26 | 43.16 | 24.47 | 27.03 | 25.59 | 26.59 | 29.63 | 25.94 |
|      | 03/10      | 16.80 | 22.70 | 48.06 | 25.99 | 28.26 | 37.16 | 27.21 | 29.73 | 35.63 |
|      | 03/17      | 16.99 | 23.26 | 47.84 | 25.61 | 27.70 | 53.46 | 26.80 | 29.04 | 35.74 |
|      | 03/24      | 16.47 | 23.56 | 50.91 | 25.63 | 27.90 | 42.59 | 26.44 | 28.94 | 37.06 |
|      | 03/31      | 15.59 | 18.66 | 66.67 | 25.34 | 27.00 | 60.64 | 24.81 | 27.04 | 54.63 |
|      | 04/07      | 15.36 | 18.20 | 65.91 | 23.90 | 25.59 | 63.97 | 25.06 | 26.99 | 59.73 |
|      | 04/14      | 16.17 | 20.16 | 69.19 | 24.10 | 25.60 | 70.91 | 24.10 | 26.56 | 62.13 |
|      | 04/21      | 15.94 | 18.61 | 72.37 | 24.10 | 25.76 | 69.36 | 23.06 | 24.94 | 68.44 |
|      | 04/28      | 15.93 | 17.96 | 75.10 | 22.04 | 23.49 | 80.44 | 22.10 | 24.50 | 72.77 |
|      | 05/05      | 17.23 | 22.74 | 72.31 | 22.89 | 24.71 | 79.86 | 23.44 | 25.39 | 75.79 |
|      | 05/11      | 17.80 | 22.19 | 74.06 | 23.13 | 24.50 | 83.07 | 21.79 | 24.00 | 82.83 |
|      | 05/18      | 17.10 | 20.76 | 98.03 | 21.89 | 23.83 | 85.91 | 22.34 | 24.76 | 81.63 |
|      | 05/25      | 15.11 | 19.16 | 97.39 | 22.77 | 24.51 | 83.77 | 22.90 | 25.11 | 80.24 |

ACS, air-conditioned store; RTS, room temperature store; DLS, diffused light store; RH, relative humidity; min, minimum; and max, maximum.