STORAGE DURATION, GROWTH & YIELD OF SHALLOT

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Bulbs of shallot or multiplier onion (*Allium cepa* var. *aggregatum*) were stored in wooden crates under ordinary room temperature on campus in Bayombong, Nueva Vizcaya for 5, 20, 35, 50 and 65 days, with 3 replications. After each storage period, the bulbs were planted. Results showed that storage duration significantly affected the rate of mortality, days to bulb formation and plant height at harvest but not the number of leaves and bulblets per plant, yield per plot and adjusted yield per hectare.

The highest percentage mortality (29.40%) was noted in plants stored for 5 days, the lowest (2.32%) for 65 days. The trend was that mortality decreased as storage duration increased. Results also revealed significant effects of storage duration on number of days to bulb formation, i.e., it was fewer under longer storage: 35, 50 and 65 days. It appears that the minimum storage duration is 35 days, while extending the storage duration up to 65 days causes no significant effect on the initiation of bulb formation. Plant height at harvest was significantly lower with longer storage. Data shows that bulbs subjected to long storage formed bulbs earlier and had the lowest height at harvest. However, no significant differences were observed in the number of leaves and bulblets per plant and yield per plot. Though results were not significant, an increasing trend was reflected on the number of bulblets and yield per plot from 5 to 50 days of storage. Prolonging the storage duration up to 65 days reduced the yield per plot by 12.54%. The highest return on investment (162.80%) was computed at 50 days of storage.

Keywords bulblets, bulb storage, dibble, income, mortality, mulching, multiplier onion, Nueva Vizcaya, plant characters, return on investment, storage, yield, yield components

INTRODUCTION

Allium crops are very important in Asian cooking, but the most important are onion, shallot and garlic, with Asian farmers producing more than 50% (14.6 M tons) of the world's supply of onion, including shallot (Pathak 1997).

Adding value to foods, onions are grown in and exported from many countries of the world, including Canada, China, England, Georgia, Greece, India, the Philippines, Sri Lanka, and the United States. Surprisingly, onions are a major export of Canada, which was worth $25,052 in 1998 (AAFC 1999). Not surprisingly, in the Philippines, the onion is a priority commercial crop that can generate progressive and viable markets for the country. Local demand for onion is increasing by 2.3%, while exports average 12,340 tons or 85% of the country's total volume of vegetable exports (PCARRD Farm News 2000).

Onions grown in the Philippines are of two types: the bulb and the multiplier types. Planting periods vary according to regions (Alvarez & Magda 1979). In Nueva Ecija, onion growers use only imported seeds. Regular planting starts from November to January (Alvarez 1983). For off-season planting, seedbeds are plowed and sown in August. Red varieties are planted late because they need the long warm days of April and May for proper bulb formation. White varieties are grown from September to March (De Jesus 1998 & Alvarez 1983). In the Ilocos Region, onion is widely grown throughout the year, but the best time is from October to November (Racadio 2000). In Pangasinan, onion cultivation is between September and October when typhoons are rare. According to Galon (1982), farmers start planting green onion a week after rice in October while those in hilly areas plant throughout the year. Grecia (1980) claimed that onions require long days for bulbing and give a fairly good yield if grown during the cool months of December to February in the tropics.
Still, productivity in onion remains very low in Asia, 13 t/ha, compared to 15 t/ha world average (Pathak 1997). In the Philippines, this is because onion growing is confronted with several problems. One of these is that most growers use imported seeds that are not acclimated to local conditions. According to Racadio (cited by PCARRD 2000), maintenance of good quality seeds is a complex problem due to heat damage that is attributed to desiccation and changes in enzyme structure, function and coagulation of protein due to direct cellular activity. Aside from this, the onion requires relatively lower temperature during the early stages of growth and relatively higher temperature later for proper bulbing and maturation.

The shallot (Allium cepa var. gr. aggregatum) is one of the most useful vegetables (Sagadraca 1988). A relative of the onion (Allium cepa), shallot, also known as multiplier and bunching onion, is a field-grown bulb of the lily family. It is a succulent crop grown for its leaves and small bulbs and used as a vegetable, for salads, spice and other purposes. The green leaves are as valuable as the immature bulbs as they contain vitamins A, C and folate (Innvista 2004). In Indonesia, shallot is widely used for various dishes (asiarecipe.com 2004). In France, the shallot is one of the secrets of many a chef’s fine foods (Berberoglu 2004). In Indonesia, research on shallot by Clemson University scientists from South Carolina has shown the way toward non-pesticide pest management by using a naturally occurring virus, where a single farmer can propagate enough of the virus for a whole village (Hammig 2003).

It is true that the shallot has never been as important a crop as the common onion (Allium cepa), but in order to have a year-round supply of onions in the market, the growing of the multiplier type is an alternative way because it is easy to grow as long as the soil is rich and moist, and it continues to multiply generation after generation (Innvista 2004). Its adaptation to local conditions makes it an ideal crop available year-round. It is propagated by means of the small bulbs or sets. Shallot stores well for several weeks and, if dried, lasts longer.

De Jesus (1998) reported that harvested bulbs are brought to traders to pile in large warehouses to dry and cure for a week. Bulbs are commonly dried and supplied to gardeners and commercial growers. Once dry, they are normally stored and transported in slatted or open-mesh bags (Ortiz 2001).

Studies have been conducted on tissue culture of garlic and shallot by Pateña et al (1991), Lapitan et al (1991), Rosco & Pateña (1997a and 1997b), but results have yet to be commercialized. Meanwhile, farmers prefer to plant the dry bulbs that have been stored for quite a long time, although they are relatively more expensive, because of their belief that old sets have a better germination ability and higher survival rate, produce good and healthy plants, and give better yield performance. Science has yet to prove or disprove the farmers’ contention, as the storage duration of bulbsets best for planting is still unknown experimentally. Hence this study.

**MATERIALS & METHODS**

**Materials**

To produce the experimental materials, dry bulbs were grown in plots at 5 different planting dates with 15-day intervals. Harvesting was done when each plot reached the maturity stage at about 2 months after planting. Harvesting was based on planting dates, i.e., those planted ahead were the first to be harvested, until the fifth harvest. After each harvest, the bulbs were stored. The last harvest was stored for 5 days, hence, storage durations were as follows: 5, 20, 35, 50, and 65 days.

**Experimental Design**

The Randomized Complete Block Design (RCBD) was used in this study. The area was divided into 3 blocks for the replications. Each block was further subdivided into 5 equal plots for the different treatments. The distance between blocks and that between plots were the same, 0.5 meter. There were 5 treatments, which were the storage periods: 5, 20, 35, 50, and 65 days.

**Cultural Practices and Management**

The same care and management practices were done on each plot and replication to produce healthy bulblets. The treatments varied only in the number of days of storage of the bulblets.

The area was alternately plowed and harrowed three times to make the soil fine and in good tilth. Plots, each measuring 2 x 2 meters, were thoroughly prepared and pulverized, after which basal complete and solophos fertilizers were applied following the recommended rate of 87-172-87 kg NPK/ha.

As a usual practice in onion production, mulching was done with a 5-cm thick rice straw spread on top of the plots to conserve soil moisture and to minimize the growth of weeds.

After that, bulbs were cut ¼ size at the top to encourage sprouting. Dibble was used to plant and cover the bulbs with soil. The distance of planting was 15 cm between hills and between rows. Watering followed immediately after planting.
watering was also done to ensure rapid growth and maximum yield. Hand-weeding especially at the early stages of growth was done to prevent competition for soil nutrients, water and sunlight. Purple blotch disease was first noticed after the bulbing stage, thus, the plants were sprayed with the fungicide Manzate and insecticide Magnum 5-EC, each time following the manufacturer's recommended dosage. Harvesting was done when majority of the bulbs were mature, ie, when the neck tissue began to soften and the leaves bend. The bulbs were pulled by the leaves and dried under the sun for a day.

Data Gathered & Statistical Tool

The data gathered were as follows:

1) Percentage mortality – dead plants or missing hills were determined 14 days after planting.
2) Plant height (cm) – average height of 10 sample plants in a plot measured from the ground level to the tip of the tallest leaf. Measurement was done just before harvesting.
3) Days to bulb formation – when swelling of the leaf sheaths was first noticed. Bulbing was observed by uncovering the mulch at one side of the base of a plant.
4) Number of leaves per plant – number of leaves of 10 sample plants per plot.
5) Number of bulblets – average number of bulblets per plant of the 10 sample plants in a plot.
6) Yield per plot (kg) – fresh weight of all the sample plants in a plot, including the weight of border plants.
7) Adjusted yield per hectare (kg/ha) – yield per plot multiplied by 10,000, with 5% deducted as allowance for damage or loss during harvesting and postharvest handling.
8) Return on Investment (ROI) – computed by dividing the net income with total cost of production multiplied by 100 to express as percent.

Data were subjected to analysis of variance for a randomized complete block design (RCBD). The Least Significant Difference (LSD) was used to compare the treatment means.

RESULTS & DISCUSSION

Percent mortality

Significant differences in mortality rates were noted among the treatments (Table 1). The rate was highest at 29.40% in bulbs planted after 5 days of storage (DS), and this was significantly different from the rates in all the other storage periods. At 20 DS, there was a significant decrease in mortality to 7.66%. The decrease continued to the 50th day of storage, to 2.54% mortality, and to the 65th day, to 2.32% mortality. However, these two rates were not statistically different.

The lowest rates of mortality were noted in 65 and 50 DS. The highest mortality was in bulbs planted 5 days after storage, and this was attributed to rotting. The differences between the lowest and all the other mortality rates were significant.

Racadio (as cited by PCARRD 2000) also claimed that maintenance of good-quality planting materials is a complex problem among farmers because of heat damage which is attributed to desiccation and changes of enzyme structure, function and coagulation of protein due to direct cellular activity. Ogbadu (1981) also mentioned that storage of onion bulbs is a serious problem due to sprouting, weight loss, and postharvest chemical and biochemical changes.

Days to bulb formation

Days to bulb formation (DBF) was significantly affected by storage duration (Table 1). Statistical analysis revealed that bulb formation occurred significantly earlier in 35, 65 and 50 DS. The earliest DBF was 29.67 days at 35 DS, and this was not significantly different from the DBF of 31 days at 50 DS and 29.67 days at 65 DS. All these were significantly different from the DBF of 40 days at 20 DS and 43 days at 5 DS.

Based on these results, it appears that the optimum storage duration of shallot prior to planting is 35 days, and extending the storage duration up to 65 days causes no significant effect on the initiation of bulb formation. Prolonging the storage duration beyond 35 days exposes the planting material to various storage losses.

Results of the study coincide with those of Hartmann et al (1981) who observed that dry sets formed bulbs earlier. It is noted that bulb formation in onion is affected by several factors as follows: variety, temperature and daylength, plant competition and light intensity and nitrogen supply. Frey & Anderson (1997) mentioned that the determining factor in bulb formation response is the varietal make-up. Hartman et al (1981) stated that cultivars variously have very critical photoperiod requirements for bulb formation. They also believed
that bulbing is initiated primarily by daylength and not by the age of the plant. In contrast, De Jesus (1998) pointed out that red varieties of onions are planted late because they need the long warm days for proper bulb formation and maturation. According to Yayock (1988), onion is a photosensitive crop and bulb formation takes place at warm temperatures. Hartmann et al (1981) declared that during the early stages of growth (before bulbing), onions grow better at relatively lower temperatures, but during bulbing up to harvesting and curing, higher temperatures and low relative humidity are desirable. Doty (1978) and Oda & Huda (1996) concluded that bulbing is controlled by both temperature and daylength, since bulb formation and height at harvest, as shown in treatments where the earliest bulbs formed had the lowest height at harvest. The decrease in height at harvest might be attributed to the translocation of carbohydrates in favor of the formation of compact leafsheaths known as bulbs, since the fleshy underground leaves surrounding the stem are white but as they grow and receive sunlight they produce chlorophyll.

**Number of leaves and bulblets**

Results revealed that the means in the number of leaves and bulblets per plant were not significantly influenced by storage duration (Table 1). The mean number of leaves per plant ranged from 36.63 to 58.27. Data shows that 65 DS gave the least number of leaves per plant (36.63) while it produced the second highest number of bulblets (21), very close to the highest (21.20) at 50 DS. As duration of storage extended to 65 days, the number of leaves per plant lessened.

The data simply means that shallot may be planted anytime between 5 days of storage to 65 days without causing a significant change in the number of leaves and bulblets per plant at harvest.

Hartmann et al (1981) mentioned that dry sets produce higher number of bulbs than direct seeding.

### Table 1. Horticultural characters, yield and yield components of shallot as affected by storage duration

<table>
<thead>
<tr>
<th>Days Of Storage</th>
<th>Mortality (%)</th>
<th>Days To Bulb Formation</th>
<th>Plant Height At Harvest (cm)</th>
<th>Number of Leaves</th>
<th>Number of Bulblets</th>
<th>Yield/Plot (kg)</th>
<th>Adjusted Yield/ha (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>29.40a</td>
<td>43a</td>
<td>46.77a</td>
<td>58.27</td>
<td>17.10</td>
<td>10</td>
<td>23,750</td>
</tr>
<tr>
<td>20</td>
<td>14.58b</td>
<td>40b</td>
<td>40.40a</td>
<td>46.84</td>
<td>18.47</td>
<td>10.33</td>
<td>24,541</td>
</tr>
<tr>
<td>35</td>
<td>7.66c</td>
<td>29.67c</td>
<td>29.80b</td>
<td>40.30</td>
<td>20.30</td>
<td>10.58</td>
<td>25,135</td>
</tr>
<tr>
<td>50</td>
<td>2.54d</td>
<td>31c</td>
<td>33.77b</td>
<td>42.57</td>
<td>21.20</td>
<td>14.27</td>
<td>33,883</td>
</tr>
<tr>
<td>65</td>
<td>2.32d</td>
<td>29.67c</td>
<td>30.23b</td>
<td>36.63</td>
<td>21</td>
<td>12.68</td>
<td>30,122</td>
</tr>
<tr>
<td>F-computed</td>
<td>75.82**</td>
<td>16.46**</td>
<td>7.02**</td>
<td>2.34ns</td>
<td>1.77ns</td>
<td>2.16ns</td>
<td>2.18ns</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.21</td>
<td>7.82</td>
<td>13.15</td>
<td>20.99</td>
<td>11.74</td>
<td>18.69</td>
<td>11.21</td>
</tr>
<tr>
<td>LSD: 0.05</td>
<td>0.762</td>
<td>2.947</td>
<td>8.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01</td>
<td>1.109</td>
<td>4.288</td>
<td>13.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Means within the same column followed by the same letter are not significantly different. NS = not significant.*

Temperature interacts with photoperiod. On the other hand, Bondad (1994) observed that nitrogen deficiency hastens bulbing while high nitrogen delays bulbing. The same observation was also reported by Mckee & Pfeifer (1995).

**Plant height**

Shallot stored for 35, 50, and 65 days were significantly shorter at harvest than those stored in shorter durations (Table 1). The shortest bulbs measured 29.80 cm from the ground up at 35 DS, and the tallest measured 46.77 cm at 5 DS.

Apparently, a correlation exists between days to number of leaves per plant.
Table 2. Cost & returns analysis per hectare of shallot by storage duration

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Days Of Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td><strong>Operating Expenses</strong></td>
<td></td>
</tr>
<tr>
<td>A. Labor Cost</td>
<td></td>
</tr>
<tr>
<td>Plowing (6 MAD, 2x)</td>
<td>3600</td>
</tr>
<tr>
<td>Harrowing (6 MAD, 3x)</td>
<td>5400</td>
</tr>
<tr>
<td>Seed preparation (2 MD)</td>
<td>300</td>
</tr>
<tr>
<td>Plot preparation (10 MD)</td>
<td>1500</td>
</tr>
<tr>
<td>Fertilization (6 MD)</td>
<td>900</td>
</tr>
<tr>
<td>Mulching (10 MD)</td>
<td>1500</td>
</tr>
<tr>
<td>Planting (20 MD)</td>
<td>3000</td>
</tr>
<tr>
<td>Weeding (10 MD)</td>
<td>1500</td>
</tr>
<tr>
<td>Irrigation (2 MD,3x)</td>
<td>900</td>
</tr>
<tr>
<td>Spraying (3 MD,2x)</td>
<td>900</td>
</tr>
<tr>
<td>Harvesting (10 MD)</td>
<td>1500</td>
</tr>
<tr>
<td>B. Material Inputs</td>
<td></td>
</tr>
<tr>
<td>Dry sets (1,200 kg x ₱30)</td>
<td>3600</td>
</tr>
<tr>
<td>14-14-14 (12 bag x ₱450)</td>
<td>5400</td>
</tr>
<tr>
<td>0-18-0 (9 bags x ₱400)</td>
<td>3600</td>
</tr>
<tr>
<td>C. Storage Rental</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>D. Land Rental</td>
<td></td>
</tr>
<tr>
<td>20000</td>
<td>20000</td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>90025</td>
</tr>
<tr>
<td>GROSS INCOME</td>
<td>166250</td>
</tr>
<tr>
<td>NET INCOME</td>
<td>76225</td>
</tr>
<tr>
<td>ROI (%)</td>
<td>84.67</td>
</tr>
</tbody>
</table>

Legend: MD is man-days, MAD is man-animal-days. MD = ₱150, MAD = ₱300. Price/kilo = ₱7

It can be recalled that bulbing is dependent on the variety (Frey & Anderson 1997). Other factors to bulb formation contributed to the totality of the bulbs formed. According to Nelson (1994) planting rates also influence the number of bulbs formed. Lower planting rates result in more light for individual plants and thus, more bulbs produced. Courett (1997) supported the claim of Nelson (1994) that the number of bulbs formed in the shaded plants are determined by light intensity available for photosynthesis.

**Adjusted yield per hectare**

As shown in the Table 1, the average yield per plot was not significantly affected by storage duration. The average yield in a 4 m² plot ranged from 10 to 14.27 kg. Prolonging the storage duration from 5 days to 50 days increased the yield in kg per plot. However, extending the storage duration up to 65 days decreased yield by 12.54%. From the plot size, the yield per hectare can be determined.

Since the yields per plot were found to be statistically similar, projecting this yield on a per hectare basis would result in a statistically comparable data. Results showed that 50 DS registered the highest yield per hectare with a mean of 33,883 kg. This was followed by 65 DS with a mean of 30,122 kg, then by 35 DS with 25,135 kg, 20 DS with 24,541 kg. The lowest yield was 23,750 kg at 5 DS.

Comparatively, the 50 DS outyielded the other...
SUMMARY, CONCLUSION & RECOMMENDATIONS

A field experiment in Randomized Complete Block Design (RCBD) was conducted at the Nueva Vizcaya State University Research Experimental Area, Bayombong Campus, to determine the effect of storage duration on the growth and yield, and economic profitability of shallot.

The percentage mortality decreased as storage duration increased from 5 DS to 65 DS. A similar trend was seen with number of days to bulb formation. The longer the planting bulbs were stored, the earlier the harvest bulbs were formed. Storage duration significantly influenced plant height at harvest. Mean plant height ranged from 29.80 cm to 46.77 cm. Plant height at harvest decreased as storage duration increased. The decrease in height might be attributed to early bulbing, with less plant food translocated to the leaves and more to the bulbs.

The costs of production per hectare with the imposition of the treatments are shown in Table 2. The total cost differed only in the amount paid for storage of bulbs, from ₱25 at 5 DS, to ₱325 at 65 DS, increasing at the rate of ₱75 by DS.

The gross incomes are also shown in the table, already with 5% reduction across all treatments as allowance for damage or loss during harvesting and postharvest handling. The gross incomes realized from shallot ranged from ₱166,250 to ₱237,181, the lowest amount being obtained from 5 DS and the highest from 50 DS. This was attributed to more number of developed bulbs causing heavier fresh weight and eventually higher yield per plot.

Table 2 also shows the net incomes per hectare of shallot, which was highest (₱146,931) at 50 DS. This was higher by 48.12% than the net income from 5 DS, higher by 44.4% than that from 20 DS, higher by 41.63% than that from 35 DS, and 17.97% than that from 65 DS.

The returns on investment (ROI) with the imposition of the treatments ranged from 84.67% to 162.80% (Table 2). The highest ROI (162.80%) was from 50 DS, which was 48% higher than 84.67% (the lowest) from 5 DS, 44.32% higher than 90.66% from 20 DS, 58.43% higher than 95.12% from 35 DS, and 18.04% higher than 133.43% from 65 DS.

Thus, the data shows that the relatively small ₱75 difference between treatments for every 15 days of bulb storage can contribute greatly to the ROI.

Based on the cost & return analysis, the best storage duration of shallot bulbsets for planting is 50 DS. There are two reasons for this. The first reason is that the farmer can then realize the highest net income. The second reason is that the bulbsets can themselves be sold for a higher price. The price of stored bulbs can be even be double the price of newly harvested green onions.

Acknowledgment

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