Maximizing onion and economic feasibility of growing onions from plug transplants

Final Report for ONE08-085

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Project Leader:

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Project Information

Summary:

Note to the reader: Tables referenced in this report are available on request from Northeast SARE. Call 802-656-0471 or send e-mail to nesare@uvm.edu and request final report materials for ONE08-085.

Growing onions from transplants is a growing trend in New York, because of the economic benefits of larger sized bulbs and earlier entry into the marketplace with approximately 15% of the 13,000 acres of onions now being grown from transplants. Most transplants are grown from bare root transplants imported from Arizona, which have been found to harbor the causal pathogen of neck rot, Botrytis allii and onion thrips. Cost, availability and frustrations associated with labor are increasingly more of a problem for onion growers who grow their onions from transplants. The deterrent to the alternative of purchasing locally grown plug transplants is that they cost 3-4 times more to purchase, and that in a previous study, they did not yield as many of the more lucrative jumbo-sized bulbs as bare roots. However, there may be labor savings, especially in light of a new automated plug transplanter now available, and improved quality that would more than make up for the higher initial cost of plug transplants. In this study, we demonstrated and evaluated adjustments to the standard planting configuration of onions grown from plug transplants and thoroughly compared return on seed, cost of transplants, labor costs, stand establishment, pest management, yield, grade and economic return. We found that onions grown from plugs in 288 cell trays with 2 and 3 plants per cell yielded comparably to onions grown from bare roots. In 2010, the new Ferrari® Futura Automatic Plug Transplanter will be demonstrated in the Elba muckland, NY. Once this new technology is successfully demonstrated to be economically feasible, it will be readily adopted by onion growers, and growing onions from transplants will continue to be sustainable.

Introduction:

Growing onions from transplants is a growing trend in New York, because of the economic benefits of larger sized bulbs and earlier entry into the marketplace with approximately 15% of the 13,000 acres of onions now being grown from transplants. Onions have one of the highest values of vegetable crops produced in New York State and rank sixth in the nation with a 5-year average value of $44 million. Most transplants are grown from bare root transplants imported from Arizona, which have been found to harbor the causal pathogen of neck rot, Botrytis allii (Hoepting et al. 2006) and onion thrips (Schwartz et al. 2004, Hsu and Nault, 2008, unpublished data). Cost, availability and frustrations associated with labor are increasingly more of a problem for onion growers who grow their onions from transplants. Inconsistent or poor return of bare root transplant seedlings from seed sent to Arizona is also a barrier for onion growers to efficiently grow and market their crop. For example, in 2007, the rate of return of transplants was about 40-60% due to an untimely frost during emergence in Arizona, which left growers scrambling for alternative strategies to make up for the unanticipated loss.

The deterrent to the alternative of purchasing locally grown plug transplants is that they are 3 times more expensive to purchase, and when grown using the standard planting configuration (i.e. grown in 288-cell trays with 3 plants per cell, and spaced 3 plants per hole every 8 inches in the field), they do not yield as many of the more lucrative jumbo-sized bulbs as bare roots (NESARE ONE06-057 Hoepting and Smith: Economic feasibility of using locally grown plug transplants as an alternative to importing bare root transplants in onions). However, there are several advantages of growing onions from plug transplants that would more than make up for the higher initial cost of transplants. These include: i) labor savings, especially in light of a new automated plug transplanter that is now available, which has the potential to reduce labor by 90%, ii) improved quality, because plug transplants are produced free of diseases (also demonstrated in ONE06-057), and iii) reliable rate of return on seed.

In this study, we demonstrated and evaluated adjustments to the standard planting configuration of onions grown from plug transplants and thoroughly compared return on seed, cost of transplants, labor costs, stand establishment, pest management, yield, grade and economic return.

Project Objectives:

To demonstrate and evaluate the economic feasibility of producing onions from plug transplants compared to bare roots by thoroughly comparing return on seed, cost of purchasing transplants, labor, stand establishment, pest management, yield, grade and bulb quality out of storage for three different configurations of growing onions from plug transplants.

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Research

Materials and methods:

This project was a collaborative effort between a commercial onion grower and an Extension Vegetable Specialist. Comparisons between imported bare root transplants and locally grown plug transplants were made using a late maturing long-term storage red variety that is grown from transplants specifically to gain a larger bulb size (c.v. Red Zepelen). Bare roots were planted singly every 4 inches. The “industry standard” configuration for plug transplants consisted of plants grown in 288 cell trays with 3 plants per cell and 8 inch plant spacing with 3 plants per hole in the field, which was compared to: i) 288 cell trays with 2 plants per cell and 8 inch plant spacing with 2 plants per hole in the field, and ii) 512 cell trays with 2 plants per cell and 8 inch plant spacing with 2 plants per hole in the field. Bare root transplants were grown by Sunbelt in Buckeye, AZ and plug transplants were grown by Triple P in Oakfield, NY. The different treatments were planted side by side in the same field with approximately 0.33 acre per treatment. The trial was planted on May 8 and 9, 2008 on 60 inch beds with 4 single rows per bed and 15 inch row spacing. The planting configurations for each treatment are summarized in Table 1.

Return on seed:

This is the percentage of the total seed sent to the transplant producer that is returned to the grower as transplant seedlings. For bare root transplants, this value was estimated by the grower cooperator. For plug transplants, percent return on seed was estimated by taking emergence counts in the greenhouse. Four trays per treatment (288-3, 288-2 and 512-2) were randomly selected, and number of plants per cell counted in 10 randomly selected rows (10-12 cells per row) per tray.

Field evaluations:

Each treatment was approximately 0.33 acre in size, which was divided evenly into 5 replications. The grower cooperator timed how long it took his crew to plant each transplant type. Stand establishment was measured 2 (19-May) 12 (16-Jul) weeks after transplanting by counting the number of plants per hole in 5 randomly selected sub-samples of 10 holes in a row per replicate. Number of leaves per plant was counted, and height of the tallest leaf per plant measured 2, 5 (15-Jun), and 12 weeks after transplanting exactly as described for stand counts. Similarly, number of onion thrips and Botrytis leaf blight lesions per plant were counted 5 and 12 weeks, and 12 weeks after transplanting, respectively.

Harvest evaluations:

The trial was harvested on August 26. For each treatment, all of the onions in a 5 x 5 ft section of bed were harvested per replicate. Onions were pulled, windrowed, topped, sorted into size classes (small: 1.75-2”; medium: 2-3”; jumbo: >3”; and culls) and weighed. After natural field curing, they were stored in a commercial onion storage.

Transplant inspection for disease and bulb quality evaluations:

Prior to transplanting, 10 bundles (25-100 plants per bundle) of bare roots and 2 randomly selected trays of plug transplants per planting configuration were randomly selected for a latent B. allii bioassay which was performed as previously described by Hoepting et al. 2006. After 3.5 months in storage, bulbs were evaluated for Botrytis neck rot and bacterial rots.

Statistical analysis:

Significant differences among treatments were determined by a General Analysis of Variance and Fisher's Protected LSD test (p = 0.05).

Economic Analysis:

The grower cooperator kept detailed records on the costs of seed, transplant production, shipping of transplants, labor, pesticide applications, and the price of the different bulb size classes. Input costs included cost of seed, transplants, and transplanting, including labor. Yield, bulb size, price per bulb size, and storage losses were also included in the economic analysis. Cost estimates were made on a per acre basis.

Research results and discussion:

Return on seed (Table 2):

This is the percentage of the total seed sent to the transplant producer that was returned to the grower as transplant seedlings. Return on seed of bare roots was estimated by the grower cooperator to be approximately 70%. Plug transplants yielded a higher percent return on seed (86 – 91%) with the 512 cell trays with 2 plants per cell having the highest (91%). The number of cells with the accurate number of plants per cell was only 53% in the 288-cell trays, due to approximately 30% of the cells having one less than the accurate number of plants per cell and approximately 7% of the cells having zero plants. The 512 cell trays with 2 plants per cell had 71% of the cells planted accurately with 15% having one less plant per cell and 0.5% having zero plants. In all of the plug configurations, 6 to 7 % of the cells had one more plant than the accurate number of plants per cell.

Stand establishment (Table 3):

A higher percentage of the bare roots (72%) were planted correctly compared to the plugs (44 – 56%). However, the bare roots had 111% of the targeted plant population due to 16% and 3% of the holes having 2 and 3 plants, respectively, instead of one. The less accurate planting of the plugs grown from 288 cell trays had 34% and 38% of the holes having one less than the accurate number of plants per hole, which reflected the inaccuracies of the original seeding in the trays in the greenhouse. The actual plant population of the onions grown from plug transplants grown in 288 cell trays was 81 and 84% of the target population for 3 and 2 plants per cell, respectively. Of the plug transplants, those grown in 512 cell trays with 2 plants per cell were planted with the most accuracy (56% of holes planted correctly). Because 14% of the cells had one less and 15% had one more plant than desired, the resulting actual plant population was 95% of the targeted population.

Plant size (Table 4):

Bare root transplants had significantly more leaves per plant (22-May: 1.8; 11-Jun: 6.5; 16-Jul: 9.6) than any of the plugs, followed by the plug transplants grown in 288 cell trays with 2 plants per cell (22-May: 1.6; 11-Jun: 5.5; 16-Jul: 9.2), which had significantly more leaves per plant than plug transplants grown in 288 cell trays with 3 plants per cell (22-May: 1.4; 11-Jun: 5.0; 16-Jul: 8.6) and plugs grown in 512 cell trays with 2 plants per cell (22-May: 1.4; 11-Jun: 4.6; 16-Jul: 8.5) at 2, 5 and 12 weeks post transplanting. The plugs grown in 288-cell trays with 2 plants per cell had significantly the tallest plants by 2-8 cm and 5-10 cm, 2 and 6 weeks after transplanting, respectively, but 12 weeks after transplanting, they were not significantly different than the bare roots or plug transplants grown in 288 cell trays with 3 plants per cell. Plugs grown in 512 cell trays with 2 plants per cell had

significantly the shortest plants all season long. Often, plant size, especially number leaves, directly translates into final bulb size. Large, healthy plants during the growing season are an indication of big bulbs at harvest.
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Pest pressure (Table 5):

Onions grown from plug transplants consistently had significantly higher numbers of onion thrips per plant, which was also observed in the previous study (NESARE ONE06-057). These differences were to the extent that the threshold to start spraying insecticides for onion thrips would have been reached sooner in the onions grown from plug transplants. No differences in Botrytis leaf blight were observed among the different planting configurations.

Yield and bulb size (Table 6):

Onions grown from plugs in 288 cell trays with 3 plants per cell had numerically the highest yield in the trial (387 cwt/A), which was 44, 47 and 80 cwt/A higher than plugs in 288 cell trays with 2 plants per cell, bare roots, and plugs in 512 cell trays with 2 plants per cell, respectively. The highest yield for plugs in 288 cell trays with 3 plants per cell was in part, a reflection of this planting configuration also having the highest plant population per acre. Bare roots had significantly 3 times as much jumbo weight and 3.5 times less small weight as plugs in 288 cell trays with 3 plants per cell. Compared to bare roots, plugs in 288 cell trays with 2 plants per cell had similar yield, and significantly the same weight of jumbos and smalls per acre. Plugs grown in 512 cell trays with 2 plants per cell had the lowest yield, no jumbos and similar weight of smalls as plugs in 288 cell trays with 3 plants per cell. Bare roots had the highest cull weight per acre due to rots, double bulbs and undersized bulbs. The 2008 trial was severely damaged by a hail storm on June 16 that caused high incidences of culls, especially to plants that had the most leaves, specifically, the bare roots and plugs in 288 cell trays with 2 plants per cell.

Botrytis allii contamination of transplants and storage quality (Table 7):

Bioassays resulted in no detection of latent Botrytis allii infection in the bare roots or plugs. Bulbs are in storage and will be evaluated for rot in January 2009. It is unknown why the bare roots were clean in 2008, but historically, these transplants have been contaminated with B. allii (Hoepting et al. 2006). Out of storage, bare root transplants had significantly the highest incidence of Botrytis neck rot and bacterial rots, which was not significantly different from the onions grown from plugs in 512 cell trays with 2 plants per cell. These treatments had 3.5 to 4 times more neck rot than those grown from plugs in 288 cell trays with 2 and 3 plants per cell. With exception of the plugs grown in 512 cell trays, the trend that bare roots have 4 times more neck rot out of storage is consistent with the results that we got in our previous study in 2006 (NESARE ONE06-057).

Economic analysis:

The target plant population was 104,544 plants per acre with exception of onions grown from plug transplants in 288 cell trays with 3 plants per cell, which had 33 % more plants at 156,816 plants per acre. Plug transplants grown in 288 cell trays with 3 and 2 plants per tray cost only 2 times more than bare roots, down from 3 times more in our previous study in 2006 (NESARE ONE06-057) (Table 8). This was due to an increased cost of shipping because of higher fuel costs, and a poorer return on seed (~70% in 2008 vs. ~80% in 2006) of bare root transplants,. Due to the use of 44% less greenhouse space, plugs grown in 512 cell trays with 2 plants per cell cost only 25% or $154 per acre to purchase compared to bare roots. It took less time to transplant plugs than bare roots by 45 minutes for plugs grown in 512 cell trays, and 1 hour 15 minutes for plugs grown in 288 cell trays. Faster planting time of plugs resulted in lower labor costs by 21 to 31% or $135 to $190 per acre for 512 and 288 cell trays, respectively. Additionally, faster transplanting would allow the onion crop grown from plugs to be planted sooner. Generally, there is a direct relationship between early planting and increased bulb size, thus, increasing the proportion of jumbo sized bulbs and net profit of onions grown from plug transplants. In this case, 0.3 to 0.6 acres more of plug transplants could be planted in a 10 hour work day, which means that a 50 acre field could be planted in 6 days less time than it would take to transplant bareroots.

Unfortunately, due to severe hail damage that occurred on July 16th 2008, yield and bulb size per acre was much lower than normal. Thus, most of the bulbs were in the lower-valued medium size class and incidence of culls due to undersized bulbs (< 1.75”), rots and double centered bulbs were much higher than normal. Without taking into consideration transplant production and planting cost and losses out of storage, the onions grown from plugs in 288 cell trays with 3 plants per cell grossed the highest ($6453), which was $667, $606 and $1492 more per acre than onions grown from bare roots ($5786), plugs in 288 cell trays with 2 plants per cell ($5847) and plugs in 512 cell trays with 2 plants per cell ($4961), respectively. The reason that onions grown from plugs in 288 cell trays with 3 plants per cell performed the best was because they were grown at a 33% higher plant population. However, it was at the expense of producing jumbo sized onions. Comparatively, the onions grown from plugs in 288 cell trays with 2 plants per cell grossed only $61 per acre less than the bare roots, and had twice as many jumbos as the plugs in 288 cell trays with 3 plants per cell. When a greater proportion of the total yield falls into the jumbo bulb size class, the difference between growing onions from plug transplants with 2 and 3 plants per cell has a greater economical impact with 2 plants per cell being more favorable. Further research is warranted to demonstrate this point.

Once the more expensive cost of producing plug transplants is factored in, onions grown from plugs in 288 cell trays with 3 plants per cell ($4785) netted only $208 per acre more than onions grown from bare roots ($4577). Onions grown from plugs in 288 cell trays with 2 plants per cell ($4315) netted only $262 per acre less than onions grown from bare roots. Onions grown from plugs in 512 cell trays with 2 plants per cell ($3733) netted $844, $1052 and $582 per acre less than bare roots, plugs in 288 cells with 3 plants per cell and plugs in 288 cell trays with 2 plants per cell, respectively (Table 9).

Highest losses out of storage occurred in onions grown from bare roots (51.7%) and plugs in 512 cell trays with 2 plants per cell (41.6%). Once these storage losses were factored in, onions grown from plugs in 288 cell trays with 3 plants per cell netted the highest per acre ($3630), closely followed by onions grown from plugs in 288 cell trays with 2 plants per cell ($3602), and then onions grown from 512 cell trays with 2 plants per cell ($1669) with onions grown from bare roots netting the least per acre ($1586) (Table 9). In our previous study in 2006 (NESARE ONE06-057), onions grown from bare roots had twice as much loss out of storage than onions grown from plugs, as a function of the bare root transplant seedlings being contaminated with Botrytis allii, the neck rot pathogen. In another study, we found that 78% of bare root transplant varieties shipped to New York onion growers in Elba had some level of B. allii contamination. Thus, it is possible that in this study, contamination of bare roots with B. allii was not detected, but in fact was the cause of higher rot due to B. allii out of storage in onion bulbs grown from bare roots. It is unknown why the smaller onions grown from plugs in 512 cell trays with 2 plants per cell also had higher losses out of storage compared to onions grown from plugs in 288 cell trays.

Research conclusions:

In conclusion, red onions grown from plug transplants grown in 288 cell trays with 2 and 3 plants per cell netted 2.3 times more than onions grown from bare roots. This was due reduced transplanting time (75 minutes less time per acre), reduced labor costs (31% or $190 per acre), comparable or higher yield per acre and 3-4 times less loss out of storage.

Growing red onions from plug transplants in 288 cell trays with 2 or 3 plants per cell is an economically feasible alternative to importing bare root transplants.

There is an automated plug transplanter that is now available, that does not work with bare roots. It requires only 1-2 laborers to operate and can be run continuously 24 hours per day, thus reducing transplanting time by 90% or more and labor costs by 50 to 70%. Now that onion growers are confident that they can achieve yields with onions grown from plugs that are comparable to those of onions grown from bare roots, they can further investigate this potential new technology. The next step is to demonstrate the automatic plug transplanter in New York. If it is a success, it could be used in commercial production as early as 2010.

Growing onions from plugs in 512 cell trays was not suitable for the jumbo red market, but may have a lot of potential for the early medium market in the Northeast US.

Participation Summary

Education & Outreach Activities and Participation Summary

PARTICIPATION SUMMARY:

Education/outreach description:

Preliminary results were presented at the Annual Elba Muck Onion Twilight Meeting on August 5, 2008, where 40 onion growers, allied industry representatives and Cornell Cooperative Extension professionals were in attendance.

This research project was highlighted on the front page of the local newspaper, the Batavia “Daily News” on August 19, 2008, along with another 2008 Partnership project funded by NESARE that was conducted by Hoepting, “Preventing erosion of muck soils by reducing tillage in onion production”.

Preliminary results of this project were presented by Hoepting to 12 Cornell research faculty and Extension Educators at the onion session of the Annual Agriculture In-Service training in Ithaca, NY, on November 12, 2008.

Results from this project as well as the NESARE Partnership project, “Economic Feasibility of Using Locally Grown Plug Transplants as an Alternative to Importing Bare-root Transplants in Onions”, funded in 2006, were presented by Hoepting at the National Allium Research Conference, held in Savannah, Georgia, on December 11, 2008 to an audience of 94 university and government researchers, allied industry representatives and growers from the United States, Canada, Holland, New Zealand and France. A manuscript has been published in conference proceedings. The powerpoint presentation is available on the web:

http://www.caes.uga.edu/commodities/fruits/vidalia/NARC08/index.html

Newsletter article highlighting the results of this study will be published in fall issue of regional Cornell Cooperative Extension Vegetable Program newsletter, Veg Edge, which may be distributed to other Extension newsletters in the region.

Project Outcomes

Project outcomes:

See results section.

Farmer Adoption

Results of this study encouraged our grower cooperator, Triple G Farms, to continue to grow some of their red onions for the jumbo market from plug transplants again in 2009.

Another grower in Elba, Mortellaro & Sons, is also experimenting with growing yellow onions for the early yellow market from plug transplants in 2009.

As a result of this project, arrangements were made with Oxbo International, located in Byron, NY, to have a demonstration unit of the new Ferrari® Futura Automatic Transplanter available in April and May of 2009 in the Elba muckland, NY. Hoepting submitted another Partnership grant to NESARE, “Reducing labor needs by adopting new automated technology to sustain profitability of producing onions from transplants”. Unfortunately, this grant was not funded and the unit was not demonstrated in 2009. Hopefully, it can be demonstrated in 2010.

Potential benefits from increased acreage converted from being grown from bare root transplants to plug transplants include, i) growers saving thousands of dollars in labor costs, ii) local transplant producers benefiting from increased sales of greenhouse-grown plug transplants, and iii) reduced risk of introducing pests and invasive species on bare roots imported from Arizona, which could result in savings of thousands of dollars per acre in losses and reduced pesticide sprays.

Assessment of Project Approach and Areas of Further Study:

Areas needing additional study

Successful demonstration of the Ferrari® Futura Automatic Plug Transplanter in commercial onion production in 2010. It is possible that the automatic transplanter is unable to recognize multiple plants per cell, or that the automatic fingers that pick up and load the plants cause damage to comparatively succulent onion transplants, or the narrow plant spacing of onions makes the automatic transplanter excruciating slow. However, if it can successfully transplant onions while significantly reducing the time and labor costs of transplanting onions, than onion growers will have the confidence they need to invest in and adopt this new technology.

It would be beneficial to continue to fine tune planting configurations. Specifically, studying the economic feasibility of growing onions from plug transplants for the early yellow medium market; 512 cell trays, which use less greenhouse space, may be feasible. Also, evaluating different plant spacings (i.e. 4” vs. 6” vs. 8”) in combination with different plug configurations (i.e. 288 vs. 512 vs. other cell trays, and 1, 2 or 3 plants per cell) for both the red jumbo and early yellow medium markets, would be worthwhile to study further.

In our study, it was found that onions grown from plugs in 288 cell trays with 3 and 2 plants per cell were comparable in yield to onions grown from bare roots. However, only ~ 54% of the cells had the accurate number of plants per cell, because ~ 30% had 1 less than the accurate number of plants per cell. This may have resulted in inflated jumbo sized bulbs in these planting configurations than would normally occur when most (i.e. 80 to 100%) of the tray cells were planted accurately. This should be further investigated, before final recommendations are made.

In our study, we found that the onions grown from plug transplants had significantly more onion thrips per plant than the onions grown from bare roots, to the extent that on a commercial scale, those grown from plugs would have had to be sprayed more frequently with insecticide. This occurred because the type of insecticide and application technique used at planting for control of onion maggot is different for bare root and plug transplants; the treatment used for bare root transplants also provides control of onion thrips. It would be worthwhile to evaluate new insecticide chemistries that could be applied to plug transplants for control of both onion maggot and onion thrips.

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