Improving Our Understanding of Vegetable and Flower Seed Quality

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Vegetable and flower production is increasingly important to Americans. Health conscious consumers demand a greater variety in their vegetables to ensure nutritional diversity in personal diets. Today, vegetables are viewed as low caloric sources of essential vitamins necessary for healthy growth. Some, such as the cole crops, are considered important food sources that battle human scourges such as cancer. Americans with increasing disposable incomes also continue to flock to cities as farming becomes more efficient, requiring a less substantive workforce. This trend of increasing urbanization and more flexible income has culminated in greater home construction. As these houses are built, affluent Americans surround themselves, their homes and offices more than ever before with attractive landscapes and beautiful flowers. These demographic shifts have created increasing need for improved vegetable and flower crops that is not expected to abate for the foreseeable future. Today, vegetables represent approximately 20% and flowers 10% of the farmgate value of U.S. agricultural crops, a significant portion of American agriculture. Thus, a comprehensive understanding of vegetable and flower production is justified.

Almost all of the vegetable and flower crops produced commercially use seed as the propagating unit. As a result, seed quality is central to stand establishment if successful production of the crop is to be obtained. Yet, it is surprising how little is known concerning the various aspects of seed quality in vegetable and flower crops. Generally, it can be concluded that vegetable and flower seed production and technology is not as advanced in some ways as for many agronomic crops. This can be attributed to the greater biological diversity of vegetable and flower crops that makes seed production varied and challenging. Successful agronomic seed production schemes have been established for corn (*Zea mays* L.), soybeans (*Glycine max* [L.] Merrill), and wheat (*Triticum aestivum* L.) during the last 40 years. But the numerous vegetable and flower crops produced in limited quantities have not permitted the same degree of specialization found in agronomic crops.

Other issues make a thorough understanding of vegetable and flower seed quality important. For example, many vegetable and flower seeds are considered high value. They are produced in limited quantities, many overseas where quality control maintenance is challenging. Others are marketed as hybrids requiring delicate hand pollination. On a relative economic basis, research conducted on these crops is expensive compared to higher volume agronomic crops. Seed companies must invest in research if they hope to acquire a return on investment by increasing seed costs. As a result, consumer expectation of seed performance becomes even greater.

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Further complicating this conundrum are other seed quality concerns unique to vegetable and flower production. These include seed enhancements and greenhouse production. The high value of vegetable and flower seeds has spurred interest in assuring optimum seed performance. To achieve this, seed companies have assisted precision mechanical planting of non-uniform shaped seeds by surrounding them with clay pellets. These pellets often contain nutrients and other compounds to stimulate germination. Other seeds are subjected to priming protocols using various osmotica or hydrated matric compounds to imbibe the seed under controlled conditions followed by drying to facilitate normal seed handling. The flower seed industry now markets "pregerminated" seeds where the process of germination is arrested at radicle protrusion. In each of these situations, rate of germination is enhanced permitting rapid stand establishment. But, seed quality has an important bearing on the success of seed enhancements. Only the highest quality seeds respond best to seed enhancements. Further, after priming, treated seeds are more prone to rapid deterioration. Thus, a seed quality control program is central to identifying the best seed lots for enhancements and monitoring the seed lots following treatment and prior to shipment to the consumer.

Another unique aspect of vegetable and flower seed production is their use to produce transplants to assure rapid growth and uniform spacing of the crop in the field or greenhouse. This increasing reliance on transplants has spurred the establishment of a new bedding plant industry that germinates seeds in plug flats that are subsequently marketed for transplant to bedding plant and greenhouse operators. The recent evolution of the bedding plant industry has created significant demands for improved vegetable and flower seed quality. As an example, 20 years ago, most vegetable and flower transplant growers planted seeds in rows in flats and selected those seedlings that emerged for subsequent handling. The performance of seeds under this production regime was less critical because failure of seeds to germinate was superseded by the selection of those that did. However, technical problems were encountered because plants and plant roots became intertwined in the flats leading to difficulties in separation and subsequent transplant shock. As a result, plug trays were developed where each seedling was self-contained in an individual cell that was subsequently transplanted into an individual pot or into the field. This shift from flat to plug production created important requirements by growers for high quality seeds that included:

- Each seed placed in a plug cell needed to germinate. To do otherwise resulted in unfilled plugs, inefficient use of greenhouse space, and the need to refill empty cells – a costly, time consuming operation. As an example, each unfilled cell for impatiens (*Impatiens wallerana* Hook) results in a $0.03 to $0.05 market loss to the grower.
- All seeds planted in a plug tray needed to germinate rapidly and uniformly. Rapid emergence is essential for faster greenhouse turnaround and frees up more greenhouse space for additional plants. Uniform emergence permits more accurate timing of shipments and creates a more desirable tray appearance to the buyer.

Today's vegetable and flower marketplace demands 100% filled cells in a plug tray. As a result, plug growers pay particular attention to seed germination and are willing to pay increased costs associated with high seed quality.

But, how is high seed quality determined in the vegetable and flower seed industry? What is clear is that it is not done very well. Certainly, one would expect that purity and germination testing protocols have been developed and described by AOSA and ISTA in their Rules for Testing Seeds. To some degree, that is true. However, seed companies are currently challenging many of the germination requirements for flower seeds because they believe the results do not reflect seed performance in the greenhouse. Others have speculated that germination guidelines for less popular vegetable and flower crops were not conducted rigorously, do not provide optimum conditions, and require reexamination. And, unfortunately, there are many vegetable and flower crops for which no guidelines are available. An example of this dilemma is native wildflowers that fall in and out of favor with capricious and fickle consumers. Of even greater concern, however, to standardization of vegetable and flower seed testing is the dearth of normal and abnormal seedling descriptions. How is it possible for seed analysts to obtain the same results for seeds from the same seed lot if they are using differing criteria for classification of normal seedlings? These deficiencies must be considered high priority for seed analysts and seed testing associations because the standardization of seed testing and the quality of seed test results will be compromised. This leaves the seed company and seed consumer in the unenviable position of trying to ascertain the true value of the product based on inconsistent seed quality information. Beyond establishment of credible purity and germination requirements, vegetable and flower seeds possess a challenging array of differing dormancy types. Further research will reveal that many of these dormancy traits can be alleviated using traditional approaches successfully applied to agronomic seeds. In the interim, however, seed analysts must rely on tetrazolium chloride (TZ) testing to provide an estimate of seed lot viability. But, again, these important crops have not been addressed in the AOSA Tetrazolium Testing Handbook. Critical issues such as concentration of TZ, length of staining, necessity for cutting, and, most importantly, interpretation of staining pattern need to be developed.

The importance of seed quality in vegetable and flower crops has been emphasized. Unlike agronomic seeds, these crops are often produced in differing locations than where the seeds are used. Domestically, vegetable and flower seeds are primarily produced in California and the Pacific Northwest. Increasingly, production locations are shifting to Southeast Asia, Central America, and Africa because of an abundant, inexpensive workforce to produce and pollinate the seed crop, as well as providing an ideal climate for seed maturation. However, the greater the distance of seed production from location of use creates significant challenges for seed quality control programs. It must be recognized that differing events contribute to loss in seed quality including immature or overmature seed at harvest, physical seed abuse at harvest and during transport, improper storage, and poor planting and handling.

Seed vigor tests must be developed to identify when and where changes in vegetable and flower seed quality occur in this more complex production scheme. The AOSA Seed Vigor Testing Handbook fails to provide recommendations for vigor testing of vegetable and flower seeds. In some instances, adaptations can be made to the recommendations provided for agronomic crops. In most instances, when this has been done, satisfactory seed vigor test results have not been obtained. Many seed companies use thermogradient tables as the preferred method for determining vegetable and flower seed vigor. Data acquired using this cumbersome method are difficult to interpret and the test requires excessive time for setup and obtaining results. In view of the importance of vegetable and flower seed quality, new vigor tests must be developed for these crops.

There has been no systematic discourse for highlighting and discussing the important problems confronting the production of high quality vegetable and flower seeds. This Symposium on "Vegetable and Flower Seed Quality" is long overdue in view of the increasing agricultural importance of these crops. Its purpose is to identify seed quality problems in the field, in bedding plant production, and in the laboratory. Unique problems are considered for wildflower and sweet corn (*Zea mays* L.) seeds. Priming and the addition of biological agents appear promising approaches to improving vegetable and flower seed performance and their relationship with seed quality is discussed. Finally, emphasis is given to vegetable and flower seed pathogens, the importance of seed dormancy in quality control, and current approaches to testing vegetable and flower seeds.

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