Scientia Horticulturae 154 (2013) 25–30

Contents lists available at SciVerse ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Time series regression analysis between changes in kernel size and seed vigor during developmental stage of sh_2 sweet corn (*Zea mays* L.) seeds

Y.J. Guan[a], J. Hu[a,*], Z.F. Wang[b], S.J. Zhu[a], J.C. Wang[a], A. Knapp[c]

[a] *Seed Science Center, College of Agriculture and Biotechnology, Zhejiang University, Hangzhou 310058, PR China*
[b] *State Key Laboratory of Crop Genetics and Germplasm Enhancement, Nanjing Agricultural University, Nanjing 210095, PR China*
[c] *Department of Agronomy, Iowa State University, Ames, IA 50011-1010, USA*

ARTICLE INFO

Article history:
Received 30 June 2010
Received in revised form
26 December 2012
Accepted 18 February 2013

Keywords:
Day after pollination
Germination percentage
Seed dry weight
Seed development

ABSTRACT

High vigor sweet corn seeds have higher yield potential than low vigor seeds. Relationships between kernel size and seed vigor during caryopsis development of three sh_2 sweet corn (*Zea mays* L.) cultivars were analyzed by time series regression (TSR) analysis method. The pattern of kernel development among the three cultivars was similar and the length, width, thickness, volume, fresh weight and dry weight of the seeds reached their highest values at 30, 26, 18, 26, 26 and 38 days after pollination (DAP), respectively. Meanwhile, germination percentage (GP), germination energy (GE), germination index (GI) and vigor index (VI) gradually increased and reached their highest levels at 38 DAP. The TSR analysis indicated that seed dry weight affected seed vigor more significantly than other kernel size parameters did and was positively correlated with GP, GE, GI and VI. The results suggested that sh_2 sweet corn seed vigor in different seed developmental stages could be predicted by seed dry weight.

1. Introduction

High vigor seeds usually provide increased yield potential, faster germination, more uniform emergence, improved tolerance to abiotic stress, and a reduction in sowing cost (TeKrony and Dennis, 1991; Rodo and Marcos, 2003; Vitor et al., 2012). Shrunken-2 (sh_2) sweet corn is gaining popularity in China and many other parts of the world because of its higher sugar content over the other types and its unique combination of flavor, texture and aroma. It is also an important source of fiber, mineral and certain vitamins for human consumption (Lertrat and Plulum, 2007). However, the absence of substantial starch accumulation has resulted in lower seed vigor and unsatisfactory field emergence, which severely limits sweet corn production (Fan et al., 1998). Especially for the supersweet corn (sh_2), its seed kernel is lighter in weight, shrunken in appearance, and its seed vigor is lower compared with other sweet corn types (Lertrat and Plulum, 2007).

Seed vigor is affected by seed developmental period (Gupta et al., 2005), and it has been found to be highly dependent on the date of harvest or stage of kernel maturity. Poor seed quality could result from an untimely harvest (Liu et al., 2011). Although a number of studies on sweet corn kernel growth during seed development and maturation have been conducted to provide theoretical basis for improving kernel weight or determining a suitable harvest time for the fresh market (Mazer et al., 1986; Song et al., 1997; George et al., 2003), the relation between kernel size and seed vigor during sh_2 sweet corn seed development is still unknown.

Time series regression (TSR) analysis method reveals the main quantitative dependencies between the factors of interest by analyzing the data along with time series, and can be used to simplify complex relationships using several principal factors (Cao et al., 2008). Up to now, no reports are available in which the relationships between the changes in kernel size and seed vigor during seed development in sh_2 sweet corns have been analyzed by TSR method.

This experiment was conducted to study the changes of kernel size and seed vigor parameters in F_1 seeds of sh_2 sweet corn at different seed developmental stages, and to establish TSR equations for forecasting the influence of kernel size on seed vigor. This was intended to provide a theoretical basis for the production of sweet corn seeds with high vigor.

2. Materials and methods

2.1. Experiment materials

Hybrid (F_1) sweet corn seeds (sh_2), cv. Chaotian 2018, Chaotian No. 3 and Shuyu No. 1, were studied in this experiment. Their respective parental inbred lines (six in total) were provided by Hangzhou Vegetable Science Institute, China. They were

* Corresponding author. Tel.: +86 571 88982318; fax: +86 571 88982318.
E-mail address: jhu@zju.edu.cn (J. Hu).

0304-4238/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.scienta.2013.02.016

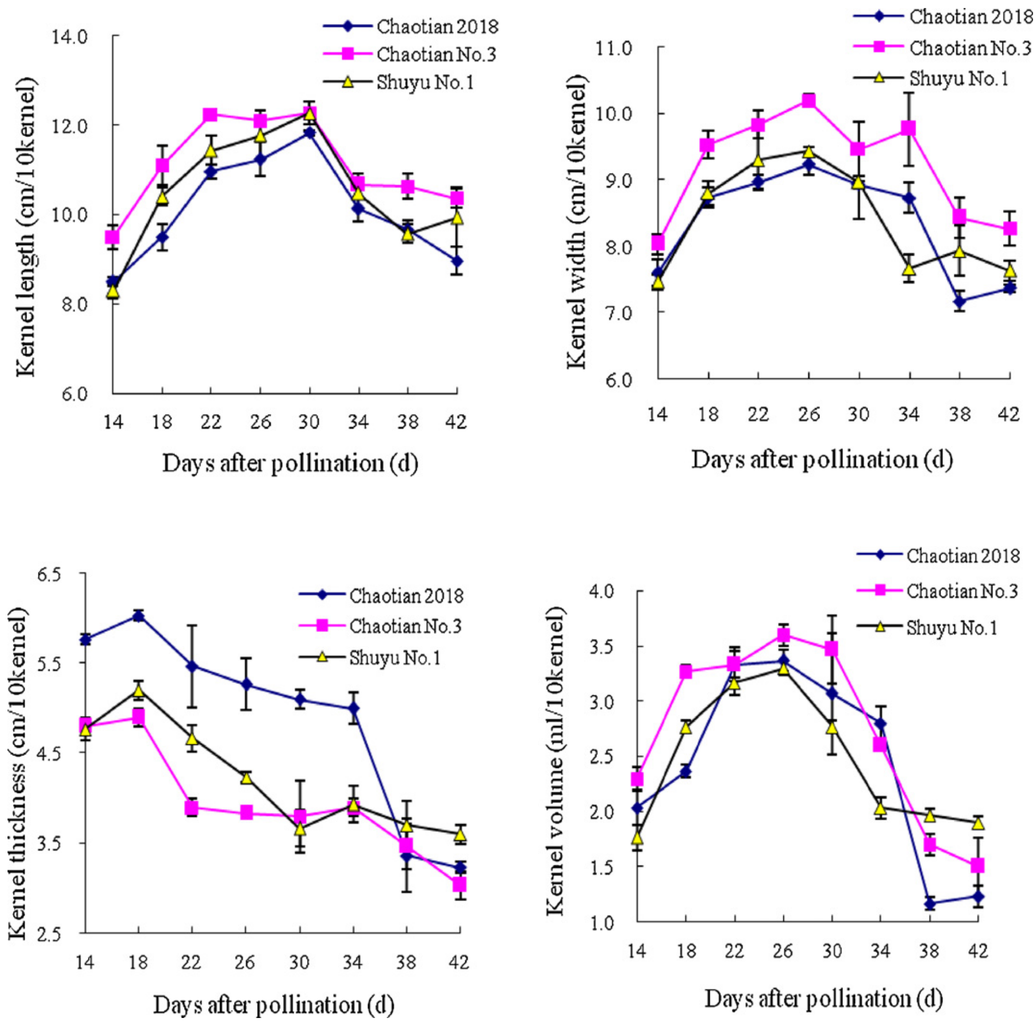

Fig. 1. The changes of kernel length, width, thickness and volume during sh_2 sweet corn seed development. S.D. indicated by bars.

produced in the same year in the field at the Hangzhou Vegetable Science Institute, China. The same planting density (4500 plants per 666.7 m^2) and seed production arrangement (4 female:1 male row) were used. Cultivation management was the same as local field production of sweet corn. Hybrid seeds were produced by synchronous hand cross-pollination of the parental inbred. Seed set (around 550 kernels per female ear) and seed maturity (around 40 days after pollination) were similar among the three female parents (Cao et al., 2008).

2.2. Seed harvest

Sweet corn ears were harvested every 4 days from 14 to 42 days after pollination (DAP). At each harvest, 10 corn plants were randomly chosen and the first ear from the top of each plant was harvested by hand. The seeds from the middle part of the ear were more uniform in development, so they were threshed by hand and mixed for further tests.

2.3. Kernel size measurement

Three replications of 100 seeds each were randomly selected from the mixed sample at each harvest. Seed length, width and thickness were measured manually with a ruler. Seed volume was determined using the "water displacement method" (Qiu et al., 2005). Seed fresh weight was obtained by weighing freshly harvested seed and the seed dry weight was determined after drying at 80 °C for 24 h (Zhang et al., 2007).

2.4. Germination tests

Germination tests were conducted with three 50-seed replicates for each harvest. Each replicate was placed on wet sand in a 12 cm × 18 cm × 9 cm germination box (Cao et al., 2008). These seeds were then incubated in a germination chamber (DGX-800E, Ningbo Haishu Safe Experiment Instrument Factory, China) at a constant temperature of 25 °C with 250 μmol m^{-2} s^{-1} light intensity and a diurnal cycle of 12 h light and 12 h darkness for 7 days (Cao et al., 2010). Germinated seeds were counted daily. The germination energy (the percentage of normal germinated seeds in all tested seeds at the 4th day for corn) and germination percentage (the percentage of normal germinated seeds in all tested seeds at the end of the full test) were calculated at 4 and 7 days, respectively (ISTA, 2010). Based on the number of germinated seeds after 7 days, germination index ($GI = \sum(G_t/T_t)$, where G_t is the number of the germinated seeds on day t and T_t is time corresponding to G_t in days) and vigor index ($VI = GI \times H_s$, where H_s is shoot height) were calculated (Muharrem et al., 2008; Hu et al., 2005).