Effects of Seed Tape and Seed Size and Shape on Hybrid Seed Corn Emergence

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Introduction

- Hybrid seed corn size and shape is determined by genetics, environment, and their position on corn ear (Fig. 1).

Fig. 1. Seed size and shape distribution on a typical corn ear (Monsanto, 2010).

- Seed production companies discard up to 3 to 10% of their small and large sized seed corn (Fig. 2).

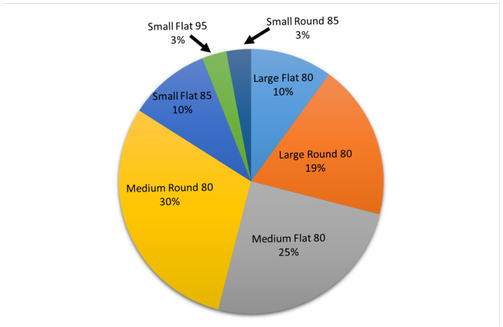

Fig. 2. Seed sizing distribution for Syngenta NK N59-Q9 corn hybrid. Number following the size and shape refers to 80K, 85K, and 95K seeds unit $^{-1}$ (Case IH, 2002).

- It is difficult to space extreme seed sizes uniformly within the row with existing planting technologies.
- Two major seed companies generate 1.6 to 2 million pounds year^{-1} of discard corn seed which includes extreme seed sizes, seeds damaged during conditioning or weathering, seed injuries, seed that goes out of quality (i.e., low germination scores), genetic purity issues (i.e., accidental seed mixtures), excess parent seed, and hybrid seed that is of good quality but is being replaced by superior genetics.
- Seed companies are looking at ways of reducing the cost of disposing discard seed. Some discard corn seed is incinerated.
- Seed tape is used to ensure uniform seed spacing and plant density of small seeded flowers, herbs, and vegetables (Chancellor, 1969).
- Extreme seed sizes (discard) may be spaced uniformly using seed tape, but little or no information is available on using seed tape for large seeded row crops.

Objective

- Determine how corn seed size and shape influences the germination and emergence of corn planted with and without tape.

Materials & Methods

- Greenhouse experiments were conducted in 2013 and 2014 at the Ohio State University.
- Six hybrid seed corn lots from four seed companies (Beck's Hybrids, Monsanto, Syngenta, and DuPont Pioneer) were evaluated. Hybrids have been identified by their relative maturity – days (d). Seed companies have not been identified in the results and discussion section and are in random order.
- Hybrid seed corn of different size and shape including discards were used in this study. Seed sizes included large, medium, small, and plateless; shapes included flat and round. Size and shape information for different seed lots was provided by the seed companies. Seed lots utilized in this study came from the same production field and the same F1 hybrid.
- Corn was embedded in tape made of biodegradable cellulose which is the material most widely used by the seed tape manufacturers.
- Seed tape and seeds were hand planted 5 cm deep in flats with commercial top soil. Greenhouse temperature was maintained at 24 ± 3 ^{0}C and metal halide lamps provided approximately 220 µmol^{-1}m^{-2}s^{-1} supplemental photosynthetic photon flux for a 16 h daily photoperiod.
- Two treatments: Seed corn of different size and shape planted with and without tape.
- Corn emergence was recorded at the first appearance of visible coleoptile, monitored until the number of emerged seedlings stabilized. Seedling counts were recorded daily for each treatment during the emergence period.
- From the seedling counts, the following parameters were calculated as previously described by Karayel and Ozmerzi (2002).

MET = Mean Emergence Time (d): $MET = \frac{N_1T_1+N_2T_2 \ldots\ldots\ldots N_nT_n}{N_1+N_2 \ldots\ldots N_n}$

($N_{1\ldots.n}$ - number of seedlings emerging since previous count; $T_{1\ldots.n}$ - number of days after sowing).

High MET indicates slow emergence; Low MET indicates rapid emergence.

ERI = Emergence Rate Index (seedlings day^{-1}units of length^{-1}): $ERI = \frac{S_{te}}{MET}$

(S_{te}=number of emerged seedlings units of length^{-1}; MET=mean emergence time)

High ERI indicates quick and uniform emergence; Low ERI indicates slow and uneven emergence.

E = Emergence (%): $E = \frac{total\ number\ of\ emerged\ seedlings}{total\ number\ of\ seeds\ planted} \times 100$

Statistical analysis:

- Treatments were arranged in a randomized complete block design with five replications and experiment was repeated twice. Total of 100 seeds was used for each treatment.
- An ANOVA was performed using SAS PROC GLM (SAS Institute, 2011) to test the effects of seed tape, seed size and shape, and seed tape-by-seed size and shape interaction on corn germination and emergence.
- Data was pooled over experimental runs, when experiment-by- treatment interactions were not significant. Means were separated using Fisher's protected least significant difference (LSD) test at $p \leq 0.05$.

Results and Discussion

Table 1. Seed tape and seed size and shape effects on mean emergence time (MET), emergence rate index (ERI), and emergence (E) of a 105 days (d) corn hybrid.

Treatments	MET (d)	ERI (seedlings day^{-1} 0.5 m^{-1})	E (%)
Effects			
Seed tape			
With seed tape	8.31 a†	0.94 b	79.50 b
Without seed tape	7.12 b	1.34 a	94.33 a
$p \leq 0.05$	*	*	*
Seed size and shape			
Very large round & very large flat *(discard)*	7.51	1.25	93.00
Tip kernels, so mostly small round *(discard)*	7.37	1.05	84.00
Larger Medium round	8.06	1.10	85.00
Larger Medium flat	7.64	1.22	91.00
Medium round‡	7.80	1.10	83.00
Medium flat‡	7.90	1.12	85.50
$p \leq 0.05$	ns§	ns	ns

† Different letters within a column indicate significantly different.
‡ Trademarked – special grade.
§ ns = not significant.

- Mean emergence index (MET) was lower in treatments without seed tape. Emergence rate index (ERI), and emergence (E) was higher in treatments without seed tape.
- MET, ERI, and E of discards and conventional seed size and shapes were not different.

Table 2. Seed tape and seed size and shape effects on mean emergence time (MET), emergence rate index (ERI), and emergence (E) of a 112 days (d) corn hybrid.

Treatments	MET (d)†	ERI (seedlings day^{-1}0.5 m^{-1})†	E (%)‡
First run			
Effects			
Seed tape			
With seed tape	5.06	1.87	90.33 b§
Without seed tape	5.10	1.84	95.16 a
$p \leq 0.05$	ns¶	ns	*
Seed size and shape			
Large - flat & round *(discard)*	5.04 bc	1.96 a	96.50 a
Small - flat & round *(discard)*	5.17 ab	1.55 c	80.50 c
Medium round	5.04 bc	1.80 b	88.50 b
Larger medium round	5.23 a	1.88 ab	94.50 ab
Medium flat	5.01 c	1.97 a	99.00 a
Larger medium flat	5.01 c	1.99 a	97.50 a
$p \leq 0.05$	*	*	*
Second run			
Effects			
Seed tape			
With seed tape	5.06 a	1.74 b	
Without seed tape	4.56 b	2.11 a	
$p \leq 0.05$	*	*	
Seed size and shape			
Large - flat & round *(discard)*	4.90	1.93	
Small - flat & round *(discard)*	5.04	1.65	
Medium round	4.85	1.83	
Larger medium round	4.70	1.95	
Medium flat	4.72	2.10	
Larger medium flat	4.65	2.07	
$p \leq 0.05$	ns	ns	

† Data not pooled as experiment-by-treatment interaction was significant.
‡ Pooled data for experimental runs as experiment-by-treatment interaction was not significant.
§ Different letters within a column indicate significantly different.
¶ ns = not significant.

- MET was lower and ERI was higher without seed tape in the second run.
- Emergence (E) was higher without seed tape. Large discards performed as well as conventional seed sizes except medium round.
- Overall, large discards performed better than small discards.

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Table 3. Seed tape and seed size and shape effects on mean emergence time (MET), emergence rate index (ERI), and emergence (E) of a 77 and 91 days (d) corn hybrids.

Treatments	MET (d)	ERI (seedlings day^{-1} 0.5 m^{-1})	E (%)
77d hybrid			
Effects			
Seed tape			
With seed tape	6.06 b†	1.33 b	79.25 b
Without seed tape	5.38 b	1.72 a	92.50 a
$p \leq 0.05$	*	*	*
Seed size and shape			
Large round *(discard)*	5.59	1.53	84.5
Small flat *(discard)*	5.64	1.63	91.5
Medium flat	5.79	1.59	89.5
Medium round	5.85	1.35	78.0
$p \leq 0.05$	ns‡	ns	ns
91d hybrid			
Effects			
Seed tape			
With seed tape	5.36 a	1.88	99.25
Without seed tape	5.25 a	1.87	98.00
$p \leq 0.05$	*	ns	ns
Seed size and shape			
Small flat - 19/16 screen split *(discard)*	5.40	1.86	99.0
Small flat - 22/19 screen split *(discard)*	5.15	1.91	98.5
Small round *(discard)*	5.40	1.85	99.0
Medium round	5.29	1.86	98.0
$p \leq 0.05$	ns	ns	ns

† Different letters within a column indicate significantly different.
‡ ns = not significant.

- In both hybrids, corn emerged earlier in treatments without seed tape. Emergence rate index (ERI), and emergence (E) were higher without seed tape in 77d hybrid.
- MET, ERI, and E of discards and conventional seed size and shapes were not different.

Table 4. Seed tape and seed size and shape effects on mean emergence time (MET), emergence rate index (ERI), and emergence (E) of a 108 and 112 days (d) corn hybrids.

Treatments	MET (d)	ERI (seedlings day^{-1}0.5 m^{-1})	E (%)
108d hybrid			
Effects			
Seed tape			
With seed tape	6.17 a†	1.14 b	62.4 b
Without seed tape	5.15 b	1.72 a	86.6 a
$p \leq 0.05$	*	*	*
Seed size and shape			
25/22 flat + round *(discard)*	5.32	1.42 a	70.5 bc
17/15 flat + round *(discard)*	6.30	1.08 b	64.0 c
22/17 round	5.64	1.41 a	73.5 abc
22/19 flat	5.61	1.61 a	81.5 ab
19/15 flat‡	5.45	1.61 a	83.0 a
$p \leq 0.05$	ns§	*	*
112d hybrid			
Effects			
Seed tape			
With seed tape	6.10 a	1.28 b	73.2 b
Without seed tape	5.28 b	1.71 a	89.0 a
$p \leq 0.05$	*	*	*
Seed size and shape			
25/22 flat + round *(discard)*	5.82	1.28 c	72.0 b
17/15 flat + round *(discard)*	5.89	1.33 bc	73.0 b
22/17 round	5.65	1.53 ab	84.5 a
22/19 flat	5.71	1.70 a	92.5 a
19/15 flat‡	5.38	1.63 a	83.5 a
$p \leq 0.05$	ns	*	*

† Different letters within a column indicate significantly different.
‡ Trademarked – special grade.
§ ns = not significant.

- In both the hybrids, mean emergence time (MET) was significantly lower whereas emergence rate index (ERI), and emergence (E) was higher without seed tape.
- 108d hybrid: *ERI:* Flat and round discards (25/22) performed as well as conventional seed sizes but significantly better than 17/15 flat and round discards. With emergence (E), there was a significant difference between 25/22 flat and round and 19/15 flats.
- 112d hybrid: *ERI:* 17/15 flat and round discards and 22/17 round performance was not statistically significant. Emergence (E) of conventional seed sizes was greater than discards.

Summary

- Seed tape-by-seed size and shape interactions were not significant for mean emergence time (MET), emergence rate index (ERI), and emergence (E). There was no evidence of a differential seed tape effect on seed size and shape.
- Treatments without seed tape had lower MET, higher ERI, and E in five of the six seed corn hybrids.
- Seed size and shape effect on corn emergence varied with hybrids. With MET, it had a significant effect in one of the six corn hybrids. With ERI and E, seed size and shape had a significant effect in three of the six corn hybrids. There was no effect on MET, ERI, and E in three of the six corn hybrids.
- Within the discards, large discards generally had lower MET, high ERI, and E than small discards.
- Large discards performed as well as conventional seed sizes in three hybrids.
- Based on the results from this study, discards associated with extreme size and shapes could be embedded in seed tape for planting because they are difficult to plant with existing planting equipment.
- Seed tape may provide a solution to facilitate uniform spacing and plant density for discards. Using seed tape to plant extreme seed sizes might offer a new approach for handling certain types of discard seed and also reduces the cost of disposing discard seed.