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By

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Grain yield and yield-related traits are the most important economic factors for bread wheat (*Triticum aestivum* L.) improvement. Grain yield (GYLD) and yield-related quantitative trait loci (QTLs) were previously identified by using a population of recombinant inbred chromosome lines (RICLs) developed from cultivar 'Cheyenne' (CNN) and its substitution line CNN(WI3A), where the 3A chromosome of cultivar 'Wichita' (WI) was substituted for the CNN chromosome 3A. The objectives of this study were to identify and validate GYLD and yield-related QTLs previously identified in CNN(RICLs-3A) studies by using the mirror population WI(RICLs-3A), where chromosome 3A of CNN and WI were now recombined in the WI background. A population of 90 F_1-derived doubled haploid lines derived from WI x WI(CNN3A) was used to evaluate GYLD, 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), spikes per square meter (SPSM), grain volume weight (GVW), anthesis date (AD), and plant height (PHT). The agronomic traits data were collected from replicated trials grown in six Nebraska environments from 2008 to 2009. Twelve QTLs associated with variation for GYLD, TKW, KPS, SPSM, GVW, AD, and PHT were detected. The phenotypic variance explained by these QTLs ranged from 12% for

SPSM to 53% for GVWT. Most of the QTLs were co-localized in a cluster or closely linked into two regions of chromosome 3A. The major grain yield QTL (*QGyld.neb.3A.1*) detected in the combined analysis explained 19% of the phenotypic variance and the substitution of a CNN allele for a WI allele decreased grain yield by 87 kg ha^{-1}. Using a different genetic background, this study detected most of the GYLD and yield-related QTLs reported in previous RICLs-3A mapping studies on chromosome 3A of winter wheat evaluated in Nebraska. The identified QTLs or genomic regions associated with GYLD and yield-related traits will be a useful tool for future marker assisted breeding in improving the yield potential of bread wheat. Additional work such as fine-mapping and cloning the QTLs for grain yield and yield-related traits will facilitate utilization of these traits in breeding programs.

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FOREWORD

This dissertation is written for publication in the format required by the Crop Science Journal.

LIST OF ABBREVIATIONS

AD - anthesis date
ANOVA – analysis of variance
CIM - composite interval mapping
cM - Centi-Morgan
CNN – Cheyenne
CNN(RICLs-3A) - RICLs with WI and CNN chromosome 3A in CNN background
CNN(WI3A) – Cheyenne with 3A chromosome from Wichita
CTAB - cetyl-trimethylammonium bromide
DH - doubled haploid
DNA – deoxyribonucleic acid
EDTA - ethylenediaminetetraacetic acid
Eps – earliness per se
GEI – genotype by environment interaction
GVW - grain volume weight
GYLD - grain yield
ITMI - International Triticeae Mapping Initiative
KPS - kernels per spike
KPSM - kernels per square meter
LOD - logarithm of odds
$Mgha^{-1}$ – mega gram per hectare
PCR – polymerase chain reaction
PHT - plant height
QTL - quantitative trait locus
QTLs - quantitative trait loci
RFLP - restriction fragment length polymorphism
RICLs – recombinant inbred chromosome lines
SD – standard deviation
SE – standard error
SPSM - spikes per square meter
SSR – simple-sequence repeat
STM - sequence-tagged microsatellites
TE – Tris EDTA
TKW - 1000-kernel weight
WI – Wichita
WI(RICLs-3A) - RICLs with WI and CNN chromosome 3A in WI background
WMC - Wheat Microsatellite Consortium

INTRODUCTION

Grain yield (GYLD) and yield components that include kernels per spike (KPS), kernels per square meter (KPSM), and spikes per square meter (SPSM) are considered the major economic traits for wheat improvement (Brancourt-Hulmel et al., 2003; Donmez et al., 2001). The genetic architecture of a quantitatively inherited trait such as grain yield is typically complex, affected by multiple interacting genes, environments, and the interaction between genes and environments that contribute to the observed phenotypic variation (Falconer and Mackay, 1996; Kearsey and Pooni 1996). However, current advancements in DNA marker technologies and statistical procedures have created new opportunities for dissecting the genetic variation of these complex traits through quantitative trait loci (QTLs) mapping (Holland, 2007; Doerge, 2002; Tanksley, 1993). QTL experiments have been done in cereals to understand the genetic basis of GYLD and the morphophysiological traits known to determine yield under different environmental conditions. However, QTLs mapped for GYLD and yield-related agronomic traits most frequently accounted for between ~2 and 10% of the total phenotypic variation (Dilbirligi et al. 2006; Quarrie et al. 2005).

In hexaploid wheat (*Triticum aestivum* L., 2n=6x=42), identification of QTLs for traits of interest on specific chromosomes is achievable through the use of unique genetic tools such as chromosome substitution lines between two parental cultivars (Berke et al., 1992a, b; Law 1966) and further localization of QTLs is obtainable by developing recombinant inbred chromosome lines (RICLs) where meaningful recombination happens only for genes on the substituted chromosome (Dhungana et al., 2007; Dilbirligi et al. 2006;

Campbell et al., 2003, 2004; Kato et al. 2000; Shah et al., 1999a, b; Araki et al., 1999; Joppa et al., 1997). Chromosome substitution lines are different for one chromosome pair while near isogenic to the recurrent parent for the remaining chromosome pairs and offer a great potential for dissecting quantitative traits of interest. When compared with recombinant inbred lines (RILs), RICLs demonstrated a very high statistical power of detecting a QTL. RICLs with a population size of 100 showed 0.98 power considering 1% Type I error rate, while at the same error rate the power for RILs with population size of 200 was only 0.41 (Kaeppler, 1997).

Berke et al. (1992a, b) evaluated a set of reciprocal chromosome substitution lines developed between two hard red winter wheat cultivars, 'Wichita' (WI) and 'Cheyenne' (CNN), to identify chromosomal locations of QTLs that influence GYLD, yield components and other agronomic performance traits. These two cultivars were selected because of their extensive use in the crossing programs of breeders for developing hard winter wheat in the Great Plains. When chromosome 3A of WI was substituted in CNN, GYLD was increased by 19% (+0.45 $Mgha^{-1}$) while the reciprocal substitution line, CNN chromosome 3A in WI background, decreased GYLD by 18% (-0.45 $Mgha^{-1}$; Berke et al., 1992a). The GYLD increase and decrease were similar in magnitude.

In order to further study the observed effect of chromosome 3A, a population of RICLs was then developed from bi-parental crosses of cultivar CNN and the substitution line CNN(WI3A). For convenience, RICLs for the 3A chromosome are written in short as RICLs-3A; when the background cultivar is CNN the population will be written as CNN(RICLs-3A); and when the background cultivar is changed to WI it will be written as WI(RICLs-3A).

Using restriction fragment length polymorphisms (RFLPs) and simple sequence repeat (SSR) markers, QTLs for GYLD, yield components, and other agronomic performance traits were previously identified in the CNN(RICLs-3A) population (Ali et al., manuscript in preparation; Campbell et al., 2004, 2003; Shah et al., 1999b). In Shah et al. (1999b) 50 CNN(RICLs-3A) lines and 14 markers (13 RFLPs and 1 morphological marker) were used to map anthesis date (AD) as a single locus (*Eps*) on the short arm of the chromosome and this morphological marker explained significant phenotypic variations in plant height (PHT), kernels per spike (KPS), and 1000-kernel weight (TKW). Additional QTLs were also identified for PHT, KPS, and spikes per square meter (SPSM); however, no QTLs were detected for GYLD and grain volume weight (GVW; Shah et al., 1999b). In a follow up study using 95 CNN(RICLs-3A) lines [the previous 50 lines from Shah et al. (1999b) and 45 new lines] and 20 markers (15 RFLPs and 5 SSR markers), Campbell et al. (2003) identified QTLs for GYLD, GVW, TKW, KPS, kernels per square meter (KPSM), SPSM, and PHT. The major grain yield QTL identified in Campbell et al. (2003) explained up to 28% of the phenotypic variance. After comparing the 3A genetic-linkage map with the physical map created by using 41 single break-deletion lines, the QTLs were localized to gene-containing regions that accounted for about 36% of the chromosome (Dilbirligi et al., 2006). In order to make a more accurate estimate and improve the resolution of the QTLs, M. Liakat Ali (personal communication) used 223 CNN(RICLs-3A) lines and 32 markers (31 SSR markers and 1 sequence tagged marker). QTLs that explained 4.6-16.8% of the phenotypic variance were detected for GYLD, GVW, TKW, KPS, KPSM, SPSM, PHT, and AD (M. Liakat

Ali, personal communication). However, no one has validated these agronomic trait QTLs using the reciprocal mapping population, WI(RICLs-3A).

QTL mapping results may vary among studies because of the use of different backgrounds, environments, and sampling variation (Holland, 2007). After the initial identification step is over, validation or testing of the QTL in a different background other than the original population is an important next step (Langridge et al., 2001). Therefore, the region of these major QTLs identified in the CNN(RICLs-3A) population must be validated and the genetic inheritance of grain yield in CNN and WI chromosome 3A needs further confirmation.

In the current study, a population of WI(RICLs-3A) where the RICLs involve WI and CNN chromosome 3A but in WI background was used to map agronomic traits previously identified in CNN(RICLs-3A). Effectively, WI(RICLs-3A) are a mirror population to the previously studied CNN(RICLs-3A) population. The hypothesis was that the previously mapped QTLs detected in the CNN(RICLs-3A) population (M. Liakat Ali, personal communication; Campbell et al., 2003; Shah et al., 1999b) would map at the same location in the WI(RICLs-3A) population. Besides validating the QTLs detected on chromosome 3A, the use of this reciprocal RICLs-3A population will also avoid the limitations of one-way chromosome substitution in determining between-chromosome interactions (Law 1966; Berke et al., 1992a). The results thus obtained should be useful in complementing our understanding of the genetics used in conventional breeding to develop wheat cultivars with higher grain yield and improved agronomic performance.

MATERIALS AND METHODS

Experimental population and traits evaluation

A population of 90 recombinant inbred chromosome lines WI(RICLs-3A) was developed through a wheat x maize (*Zea mays* L.) doubled haploid (DH) system by Dr. Mujeeb-Kazi, International Maize and Wheat Improvement Center, Mexico (Laurie and Bennet, 1988; Riera-Lizarazu and Mujeeb-Kazi, 1993). The DH lines were developed from F_1 plants of the cross between cultivar WI and chromosome substitution line WI(CNN3A). Wichita is a hard red winter wheat developed in 1944 at Kansas State University (Clark, 1945) and was extensively used in numerous crossing programs for wheat improvement in the Great Plains. The chromosome substitution line WI(CNN3A) was developed by substituting chromosome 3A of cultivar Wichita with chromosome 3A of cultivar Cheyenne, a hard red winter wheat developed in 1933 at the University of Nebraska, Nebraska, USA (Clark, 1931) and a major cultivar used in many Great Plains wheat improvement programs. The two parents and eight other check lines [CNN, CNN(WI3A), CNN(WI6A), WI(CNN6A), 'Pronghorn', 'Jagger', 'Overland', and 'Goodstreak'] were also included in order to determine if the previously reported chromosome 3A effects could be observed in the current testing environments.

The RICLs-3A population and the parents and checks were grown in 2008 at Lincoln and North Platte and in 2009 at Lincoln, Mead, North Platte, and Sidney, Nebraska, U.S.A. The testing environments are diverse and representative of the Nebraska wheat growing conditions (Peterson, 1992). The 100 entries were evaluated in three replicate field trials in an alpha-lattice incomplete block design, where each replicate consisted of 20 incomplete blocks of 5 plots. Each entry was grown in a four-row plot that was 2.4 m long with 0.3 m between rows. Planting was done at the optimal planting date for each site from mid September to the first week of October. Crop rotation at the sites included fallow-wheat, soybean [*Glycine max* (L.) Merr.]-wheat, or corn-wheat and the experiments were planted in conventionally tilled plots. All field experiments were under rain-fed conditions and plot management was done following the recommended cultural practices for the area. Though CNN was a popular and widely grown cultivar, over time it had lost some of its disease resistance, as had WI. Hence to avoid confounding effects of diseases, the trials were sprayed with fungicides and yield "potential" was actually measured. Agronomic traits evaluated in this study included GYLD, TKWT, KPS, KPSM, SPSM, GVWT, PHT, and AD. Traits were measured following the procedure outlined by Shah et al. (1999a) and modified by Campbell et al. (2003). Table 1 summarizes how the traits were measured.

Phenotypic trait data analysis

Analysis of variance (ANOVA) for AD, PHT, GYLD, GVWT, SPSM, KPS, KPSM and TKWT was performed separately for each environment using the PROC MIXED procedure (Littell et al., 1996) of SAS version 9.1 (SAS Institute, Cary, NC) where genotypes were considered as fixed effects, and replications and blocks as random effects. Prior to combined analysis, homogeneity of error variances was checked with Bartlett's Chi-square test as outlined by Gomez and Gomez (1984). In the combined analysis, genotypes were considered as fixed, and environments (location-year), blocks within environments, and genotype x environment interaction (GEI) were considered as random. The statistical significance of these components was determined by the F-test and the numerator and denominator degrees of freedom were estimated. Narrow-sense entry mean heritabilities with standard errors were estimated for the mapping population using the PROC MIXED procedure of SAS version 9.1. For the heritabilities analyses, parents and checks data were excluded. All effects were treated as random in the model following the method described by Holland et al. (2003). The basic SAS code for heritability estimate is available at http://www4.ncsu.edu/~jholland/heritability/Inbreds.html (Verified on 02 Feb 2010). Pearson's correlation coefficients between traits were calculated for the combined data by using the PROC CORR procedure of SAS.

SSR and STMs marker analysis

The WI(RICL3A) lines were genotyped with simple sequence repeat (SSR) markers gathered from the GrainGenes webpage, a freely available public data base (http://wheat.pw.usda.gov/ GG2/index.shtml) where the markers were contributed by different research groups, including WMC (Somers et al., 2004), GWM (Röder et al., 1998), BARC (Song et al., 2005), CFA and CFD (Sourdille et al., 2003; Guyomarc'h et al., 2002), PSP (Stephenson et al., 1998), GDM (Pestsova et al., 2000) and sequence-tagged microsatellites (STM) markers. STM primer sequences were obtained from Hayden et al. (2006). All primer pairs were purchased from Invitrogen Inc. (Huntsville, Alabama).

Genotyping procedures including DNA isolation, polymerase chain reactions, polyacrylamide gel-electrophoresis and SSR assays were performed following the procedure outlined by Kuleung et al. (2006) with slight modifications. Sap was extracted using the CTAB procedure (Saghai-Maroof et al. 1984) to isolate genomic DNA from 3-4 weeks-old greenhouse grown seedlings. One gram of fresh leaves was placed in between the two rollers of a sap extraction apparatus (Ravenel Specialties, Seneca, SC) and 5 ml of Extraction buffer (50 m*M* Tris-HCL, 25 m*M* EDTA, 1 *M* NaCl, 1% CTAB, 1 m*M* of 1, 10-phenanthroline, 0.15% 2-mercaptoethanol) was slowly added to the rollers. The extracted DNA was then re-suspended in 500 µl of TE buffer and the DNA concentration quantified by spectrophotometry (TKO100 Fluorometer, Hoefer Scientific Instruments, San Francisco, CA). The PCR reactions for SSR analysis were performed in a total volume of 25 µl reaction mix, containing 75 ng of template DNA, 50 ng of each primer, 0.5 units of Taq polymerase, 2.5 µl of 10 mM dNTPs, and 2.5 µl of 10x PCR buffer with 15 mM $MgCl_2$. The PCR was set up with an initial denaturation at 94 ^{o}C for 3 min, followed by 30 - 40 cycles of 94 ^{o}C for 1 min, 50–61 ^{o}C of annealing for 30 s and extension at 72 ^{o}C for 45 s, with the final extension of 10 min at 72 ^{o}C. The PCR products were analyzed on 12% polyacrylamide gels and stained with ethidium bromide for visualization. A total of 92 SSR and 20 STM markers were screened for polymorphism between the two parents. Markers that showed polymorphism between the two parents were then used to screen the population. The parental amplified DNA samples were included as controls with every set of 25 lines to facilitate scoring. Prior to map construction, all markers used for screening the population were checked by the chi-square (χ^2) test for the goodness of fit against a 1:1 segregation ratio at the 0.05 probability level.

Map construction

MAPMAKER/ EXP3.0 program (Lander et al. 1987) was used for marker diagnostics and to determine the linkage groups. MAPMAKER performs full multipoint linkage analyses (simultaneous estimation of all recombination fractions from the primary data). The linkage groups identified on chromosome 3A were considered not linked if the distance between flanking markers was greater than 37.2 cM and the logarithm of odds (LOD) score was not less than 3. Centi-Morgan units were calculated using the Kosambi mapping function (Kosambi, 1944). Co-segregating markers (defined as mapping within a 0.2 cM interval) were excluded from the final map and only one marker for each cluster was retained.

QTL analysis

Identification of QTLs was performed by the composite interval mapping (CIM) (Zeng 1994) method of WinQTL cartographer v.2.5 (Wang et al., 2007; http://statgen.ncsu.edu/qtlcart/WQTLCart.htm, verified on 05 Feb. 2010) using the least squares means data of each trait separately for each of the six environments and the average values across all the environments. The threshold for declaring the presence of a significant QTL for each trait–environment combination was defined by 1000 permutations at $P \leq 0.05$ (Churchill and Doerge, 1994) in order to handle non-normality in both the marker and the trait data. The walking speed chosen for all traits was 1 cM. Cofactors were determined following the standard CIM model, using the forward-backward regression method with a probability in and out of 0.1. The position where the logarithm of odds (LOD) score curve reaches its maximum was used as the estimate of the QTL location. The value of the additive effect (*a*) at each QTL peak LOD score positions was computed as half of the difference between the mean phenotypic values of the two groups of RICLs, based on the information of the flanking markers and with the assumption that all lines were homozygous for one or the other of the parental alleles at that QTL region. In particular, the additive QTL effect *a* was defined as ½[WI(CNN3A) - WI]; therefore *a* was positive when the CNN allele showed the higher value. The percentage of phenotypic variance explained by a QTL was estimated as the coefficient of determination (R^2) using single-factor analysis from a general linear models procedure (Wang et al., 2007). For each QTL, R^2 was determined for the single marker closest to the identified QTL. The QTLs detected above the LOD threshold (LOD ≥ 2.5) that explained more than 10% of the variance in at least one environment were arbitrarily classified as major QTLs and those explaining less than 10% as minor QTLs. A 95% confidence interval was established by marking ±1 LOD score marker positions, following Lander and Botstein's (1989) 'lod drop-off method.' QTLs detected in different environments were considered to be the same if the estimated map position of their peaks fell within 20 cM of each other. The QTLs identified were named following the nomenclature suggested by the catalog of gene symbols for wheat (http://wheat.pw.usda.gov/ggpages/wgc/98). The QTL map from this study was compared with the previous map developed for CNN(RICLs-3A).

RESULTS AND DISCUSSION

Linkage map construction

A total of 112 markers (90 SSR and 22 STM) were scored on the parents of the WI(RICLs-3A) mapping population and 33 SSR (36%) and 2 STM (9%) markers produced polymorphic fragments. Segregation distortion was not detected for any of the polymorphic markers; none differed significantly from the expected 1:1 segregation ratio. Nine of the 35 polymorphic markers that either co-segregated or mapped within a 0.2 cM interval were removed after running an initial mapping procedure. The final chromosome 3A linkage map was constructed with 26 markers (25 SSR and 1 STM) that spanned approximately 100.2 cM in length (Fig. 1). In the previous CNN(RICLs-3A) studies, the total map length of the chromosome in Shah et al. (1999b), Campbell et al. (2003) and M. Liakat Ali (personal communication) was 96.7, 120, and 106 cM, respectively. The minor total map length difference among the studies may be due to the difference in the type of markers used, the number of meiosis events that occurred in the different populations, and/or the size of the population (Somers et al., 2004). Considering common markers, the order of markers was in good agreement with the previously published wheat genetic maps (Song et al., 2005; Somers et al., 2004). Chromosome 3A map of Campbell et al. (2003) consisted of 15 RFLP and 5 SSR markers and all of the SSR markers were ordered similarly to our current map. The density of markers on the map was good and the average distance was 3.85 cM between two markers. All SSR and STM markers assayed in the distal region of the 3AS chromosome were found to be monomorphic. The low marker density at this region of the chromosome might be due to a high recombination rate which is a general feature of wheat chromosomes (Röder et al. 1998; Sourdille et al. 2003; Somers et al. 2004). It is also possible that the distal end of the chromosome could be consistent (identical by descent) due to selection and will remain monomorphic.

Field data analysis

WI and WI(CNN3A) were significantly different from each other for GYLD, KPSM, GVWT, AD, and PHT (Table 2). However, in a few individual environments and in the combined data set the parents were similar for TKW (Lincoln 2008, North Platte 2008, North Platte 2009, and in the combined data set), KPS (Mead 2009 and in the combined) and SPSM (Lincoln 2008, Mead 2009, and North Platte 2009). Both Berke et al. (1992b) and Campbell et al. (2003) reported non-significant differences for TKW between the WI 3A and CNN 3A chromosome and non-significant KPS and SPSM were also reported by Campbell et al. (2003). When compared with WI, WI(CNN3A) was significantly lower in grain yield by 14% averaged over the 6 environments and often achieved grain yields near the lower end of the population range (Table 2). Hence the parental lines behaved as expected and if the traits are controlled by QTLs, we should identify them in the progeny.

All traits showed continuous variation with most having near normal distributions in the WI(RICLs-3A). The test statistics for skewness and kurtosis done on means within each environment and over six environments were less than 1.0 (data not shown), indicating suitability of the data for QTL analysis. The RICLs-3A population showed transgressive segregation for most of the traits measured in the 6 environments, except for AD (Mead 2009); PHT (Lincoln 2008 and North Platte 2008); GVWT (Sidney 2009); and SPSM (Sidney 2009). Generally, for most of the traits where there was transgresive segregation in the mapping population, the parents showed significant differences. However, for traits such as TKW, KPS and SPSM with no significant difference between the two parents, the mapping population showed transgressive segregation. Transgressive segregation can be caused by favorable alleles coming from both parents, the breakage of linkage between a favorable and an unfavorable allele or due to statistical measure where small QTLs are missed or where in 90 lines at the 5% confidence level we expect 2 lines to be declared significantly higher or lower than the parent lines. This research concentrates on QTL identification.

Heritability estimates (h^2) of the WI(RICLs-3A) population across environments varied from trait to trait, and ranged from 0.47 (SE=0.01) for KPS to 0.93 (SE=0.1) for AD combined over environments (Table 2). The ANOVA for all traits revealed significant differences ($P<0.01$) among lines for all traits at all environments (Appendix 4). Genotype × environment interaction variance was also significant ($P < 0.01$) but small in comparison to genotype variance.

In order to determine the phenotypic relationships that existed among traits, correlation coefficients were calculated using across environment least squares means (Table 3). Grain yield was positively correlated with TKW, KPSM, SPSM, and GVWT, but negatively correlated with PHT and AD. KPSM had the highest correlation with GYLD (r=0.89, $P \leq 0.001$) followed by SPSM (r=0.77, $P \leq 0.001$) and GVWT (r=0.65, $P \leq 0.001$). The observed high correlation between GYLD and KPSM and SPSM was expected because these traits are derived by using GYLD. Similar trends of correlations were reported for grain yield in previous RICLs-3A studies (Campbell et al., 2003; Shah et al., 1999a; M. Liakat Ali, personal communication), with the exception of non-significant correlation for TKW in Campbell et al. (2003). Except with GYLD and GVW, TKW showed non-significant correlations with the other traits measured in this study. Significant negative correlations were found between KPS and SPSM and between SPSM, PHT, and AD. Later lines were taller and lower yielding, with fewer tillering, but had more seed per spike and the seeds were smaller. There were significant positive correlations among KPS, AD, and PHT. The highly correlated responses observed between GYLD, yield component traits (TKW, KPSM, SPSM), and GVW and between PHT and AD may be due to pleiotropy that existed among these traits. Thus, we cannot reject the hypothesis that these closely related traits may be controlled by common major genes.

QTL analysis

Increasing grain yield is a major goal for bread wheat improvement. However, direct study on grain yield alone does not overcome the challenges of improving this complex trait which are influenced by many processes involving vegetative and reproductive growth and developmental stages, and by their interactions with the environment. Therefore, it was helpful to dissect GYLD into its yield components, and other related agronomic traits including GVW, PHT, and AD. Searching for QTLs of grain yield and grain yield-related traits in bread wheat had been the focus of many researchers (Kuchel et al., 2007; Marza et al., 2006; McCartney et al. 2005; Huang et al., 2004, 2006; Groos et al., 2003; Börner et al., 2002).

Two regions of chromosome 3A were shown to be associated with QTLs (Fig. 1). Region 1 was the interval from *Xbarc86* to *Xstm6352* (11 cM interval) and region two was the interval from *Xhbg284* to *Xcfa2193* (11 cM interval). All significant QTLs identified by CIM in individual environments and across environments are summarized in Table 4. When a QTL for a given trait was detected in more than one environment and the peak of that QTL in other environments was within a region ≤ 20 cM of the first peak then it was considered as the same QTL. In total, 12 QTLs were detected for 7 of the 8 measured traits that included two each for GYLD, GVW, PHT, AD, and TKW; and one for KPS and SPSM (Fig. 1 and Table 4). There was no significant QTL detected for KPSM. QTLs of both PHT and GVW were consistently expressed and significant in five of the six environments. The phenotypic variance explained by the QTLs detected in this study ranged from 12% for SPSM to 53% for GVW. As expected, many of the QTL peak positions for the different traits were clustered in the same genomic region. The clustering of QTLs found in this study and the previous RICLs-3A studies (M. Liakat Ali, personal communication; Campbell et al., 2003; and Shah et al., 1999b) supports the pleiotropy hypothesis for most of the yield-related QTLs identified in multiple environments and in different populations. In order to further investigate the clustering of QTLs for yield-related traits, high-resolution mapping will be required to distinguish between pleiotropy and linkage.

QTLs for grain yield

Composite interval mapping detected two GYLD QTLs (*Qyld.neb-3A.1* and *Qyld.neb-3A.2*) in WI(RICLs-3A) both located on the short-arm of chromosome 3A. The *Qyld.neb-3A.1* QTL was detected in Lincoln 2008, North Platte 2009 and in the combined analysis in the interval *Xbarc86-Xwmc388.1*, with the peak LOD score associated with *Xwmc640*. Based on the trait-marker association, the phenotypic variance explained by this QTL for the combined analysis was 19% and the substitution of a CNN allele for a WI allele decreased GYLD by 87 kg ha^{-1} (Table 4). In Campbell et al. (2003), this QTL was detected in the interval *Xcdo638-Xbarc67* and the phenotypic variance explained for the combined analysis was 28%. M. Liakat Ali (personal communication) mapped this QTL in the *Xwmc664-Xbarc67* interval and the amount of phenotypic variance explained was 5%. In both Campbell et al. (2003) and M. Liakat Ali (personal communication) the substitution of a WI allele for a CNN allele increased grain yield by 66 kg ha^{-1} and 47 kg ha^{-1}, respectively. Based on the common markers and the position of the QTL, it is believed that *Qyld.neb-3A.1* detected through direct mapping of the grain yield phenotype in this study was located within similar map intervals as the *Qyld.unl-3A.2* detected by both Campbell et al. (2003) and M. Liakat Ali (personal communication). The second GYLD QTL, *Qyld.neb-3A.2*, in the WI(RICLs-3A) population was detected only in the combined analysis in the interval *Xstm6352-wmc428*, with the peak LOD score associated to *Xhbg284*. The phenotypic variance explained by this QTL was 17% and the substitution of a CNN allele for a WI allele decreased GYLD by 82 kg ha^{-1} (Table 4). The presence of a GYLD QTL in this region was not previously reported in CNN(RICLs-3A) studies, however, the peak LOD score position of *Qyld.neb-*

3A.2 was close to *Qyld.neb-3A.1* (13.1 cM) detected in this study and within a similar region as the Campbell et al. (2003) and M. Liakat Ali (personal communication) *Qyld.unl-3A.2* QTL. If the confidence interval is relaxed from 1 LOD score to 2 LOD score, the two GYLD QTLs will overlap and can be considered as a single QTL. The minor grain yield QTL previously identified in the distal part of the short-arm region of the chromosome in Campbell et al. (2003) and M. Liakat Ali (personal communication) was not detected in the WI(RICLs-3A) mapping population in this study. This may be due to environmental differences in the locations where the RICLs-3A populations were grown or an epistatic interaction between the QTL and the genetic background (e.g. found in CNN, but not in WI). There was a slight variation in LOD scores and contributions to the phenotypic variance between the CNN(RICLs-3A) and WI(RICLs-3A) studies; however, the LOD score peak positions and the desirable allele at each of the GYLD QTLs were very consistent.

QTL for 1000-kernel weight

Two regions of the chromosome were associated with TKW in two environments (Lincoln 2008 and North Platte 2008) and in the combined analysis (Table 4). *Qtgw.neb-3A.1* and *Qtgw.neb-3A.2* QTLs were detected in the interval *Xbarc86-Xwmc664* and *Xstm632-Xhbg284* each explaining 21% and 19% of the phenotypic variance, respectively. Similar to GYLD, in each case the favorable alleles of TKW were also contributed by the WI parent. There was no significant TKW difference between the parents in any of the six environments tested; however, there were transgressive segregants for this trait and QTLs were detected with 3.4-4.9 LOD score (Table 2 and

Table 4). In previous RICLs-3A studies alleles of both parents were considered as contributors to an increase in TKW. In Shah et al. (19991b), increased TKW was due to the WI allele, while in Campbell et al. (2003) and M. Liakat Ali (personal communication) the favorable allele was from CNN. Berke et al. (1992a) reported a significant TKW increase for the WI 3A chromosome (11% increase in TKW of Cheyenne) but no significant effect for CNN 3A in WI. If both parents contributed to favorable and unfavorable alleles of TKW, the mapping population may show transgressive segregation and the parental values may be not significantly different from each other. Fine mapping of WI(RICLs-3A) may be used to precisely identify the effect of favorable alleles coming from both parents. In current study, the additive effect contributed by the WI allele was less than 1 gm (Table 4). Thousand kernel weight is highly influenced by the environmental conditions that occur during the grain filling period when the crop is more susceptible to drought and heat stress and hence will remain the most variable yield component trait (Donmez et al., 2001). The difference in the parental allele contributions among the current and the previous studies may be due to differences in the environments where the mapping populations were grown.

QTL for kernels per spike

There was only one minor KPS QTL identified at Sidney during the 2009 cropping season (Table 4). At Sidney the two parents separated by 2.3 kernels per spike, with the WI(CNN3A) parent having more KPS than WI (Table 2). When averaged over the six environments, there was no significant difference in KPS between WI and WI(CNN3A). Berke et al. (1992a) also found a similar non-significant difference between WI and WI(CNN3A). In the CNN(RICLs-3A) studies (Shah et al., 1999b; Campbell et al., 2003; and M. Liakat Ali, personal communication), there was no significant difference in KPS between the parents, CNN and CNN(WI3A). In this study, *QKps.neb-3A* was identified associated with KPS in the interval *Xwmc640-Xbarc356* with the peak LOD score near *Xwmc664*. This QTL explained 13% of the phenotypic variance that translated to an additive effect of 0.51 kernels with the CNN allele contributing the higher value at *QKps.neb-3A* for an increase in KPS. M. Liakat Ali (personal communication) and Shah et al. (1999b) also detected a KPS QTL at a similar position with the QTL detected in this study in three different environments with the CNN allele each time providing the higher value. There was no KPS QTL in Campbell et al. (2003) at a similar region as in the current study; however, two separate QTLs were identified and both the WI and CNN alleles provided the higher KPS value.

QTL for spikes per square meter

A significant QTL for SPSM was identified at North Platte during the 2009 cropping season and in the combined analysis. The *QSsm.neb-3A* QTL was located in the interval *Xgwm218 - Xwmc640* with the peak LOD score associated with *Xbarc86* (Fig. 1 and Table 4). This QTL explained phenotypic variance ranging from 12% in the combined analysis to16% at North Platte 2009 (Table 4). In the *QSsm.neb-3A* QTL the substitution of a CNN allele for a WI allele reduced SPSM by 9-18 spikes. This QTL was detected at a similar position in Campbell et al. (2003) and M. Liakat Ali (personal communication) and in each case the favorable allele was contributed by WI.

QTLs for grain volume weight

High grain volume weight, also called test weight, is an indicator of sound grain with high flour yield and is often associated with milling yield (Clarke et al., 1998; Kurnert et al., 2007). Two QTLs were identified for GVW (Fig.1, Table 4). The *QGvw.neb-3A.1* QTL was identified in five of the total six environments. In the combined analysis, *QGvw.neb-3A.1* was detected in the interval *Xbarc86-Xstm6352* with a peak LOD score of 14.9 at the marker *Xwmc388.1* explaining 53% of GVW variation. The *QGvw.neb-3A.2* QTL was identified only at North Platte during the 2009 cropping season. At North Platte 2009, *QGvw.neb-3A.2* appeared as a second peak in an approximately 14 cM interval from *QGvw.neb-3A.1* (Table 4). *QGvw.neb-3A.2* was located in the interval *Xstm6352-Xwmc428* with the peak LOD score near marker *Xhbg284* accounting for 32% of the phenotypic variation at North Platte. In both QTLs the CNN allele consistently reduced GVW with minor differences across environments. In a previous RICLs-3A study Campbell et al. (2003) reported, for the combined analysis, a GVW QTL at a similar region as in the current study which explained 43% of the phenotypic variation. The QTL position in the current study was also in good agreement with that of M. Liakat Ali (personal communication) *QGvw.unl-3A.2*. In both Campbell et al (2003) and M. Liakat Ali (personal communication), the CNN allele decreased GVW as it did in this study.

QTLs for plant height

Two significant QTLs were detected for PHT with LOD score values ranging from 3.1 to 7.1 and explaining 15-31% of the phenotypic variance (Table 4). In both

QTLs, the higher value of PHT was contributed by the CNN allele with an additive effect of 1.5 - 2.2 cM. The first PHT QTL, designated as *QHt.neb-3A.1* was detected in two environments (North Platte 2008 and 2009) and in the combined analysis in the interval *Xbarc86* - *Xbarc67*; the peak LOD score was associated with *Xwmc640*. The other PHT QTL, *QHt.neb-3A.2*, was identified in four environments and in the combined analysis in the interval *Xstm6352* - *Xhbg284*, with the peak of the LOD score near *Xhbg284*. These PHT QTLs were also previously identified by Campbell et al. (2003) and M. Liakat Ali (personal communication) and in both cases the taller QTLs for PHT were contributed by the CNN alleles as was found in this study.

QTLs for anthesis date

The control of AD significantly affects the reproductive capacity of cereals and has a major impact on the final grain yield (Cockram et al., 2007). The presence of earliness per se genes (*EPS* genes) on chromosome 3A of wheat was repeatedly reported by different authors (Hoogendoorn 1985; Zemetra et al., 1986; Berke et al., 1992a; Miura and Worland, 1994; Miura et al., 1999). Two significant QTLs associated with AD were identified at North Platte during the 2008 cropping season, with approximately 13 cM distance between the LOD score peaks (Fig. 1 and Table 4). *QAdt.neb-3A-1* was located in the interval *X barc86* - *stm6352*; the peak LOD score was associated with *Xwmc640* and explained 23% of the phenotypic variance. *QAdt.neb-3A-2* was located in the interval *Xstm6352-Xhbg284* and explained 19% of the phenotypic variance. In both QTLs the substitution of a CNN allele for a WI allele increased AD by about half day. According to Zemetra et al. (1986), a study based on reciprocal substitution lines, chromosomes 3A of Wichita appeared to carry major genes that decreased AD while Cheyenne carried major genes that increased AD. Also in previous RICLs-3A mapping populations studies, Shah et al. (1999b) and M. Liakat Ali (personal communication) identified regions of chromosome 3A associated with AD. The AD QTLs detected in the current study were at a similar position as M. Liakat Ali (personal communication) *QAdt.unl.3A.2*. In Berke et al. (1992a), AD of CNN was significantly better than CNN(WI3A) but WI and WI(CNN3A) were not significantly different (P>0.05). Generally, finding an AD QTL in the RICLs-3A population was difficult perhaps due to the sensitivity of the EPS locus or the large effect of genotype by environment interactions on AD. In addition, in the current study there was low correlation of AD least square means among environments (Appendix 2) and variable expression of the AD QTL in different environments (Table 4).

CONCLUSIONS

In the current study most of the QTLs controlling GYLD, yield component traits, GVW, PHT, and AD were co-localized in a cluster or closely linked into two regions of chromosome 3A. The directions of their additive effects were also consistent in the different environments, which explained the genetic basis of significant correlations that existed among their phenotypic characters. Using a different genetic background (WI), this study validated the QTLs for most agronomic traits affecting grain yield on chromosome 3A reported in previous studies using CNN(RICLs-3A) mapping populations. The current mapping population WI(RICLs-3A) is effectively a mirror population to the previously studied CNN(RICLs-3A).

A major QTL for grain yield, *Qyld.neb-3A.1*, derived from a high yielding cultivar Wichita, has been identified in the current study. The WI alleles in the previous CNN(RICLs-3A) studies (Shah et al., 1999; Campbell et al., 2003; M. Liakat Ali, personal communication) detected an increase in grain yield and yield components traits and as expected the CNN alleles in the current WI(RICLs-3A) study showed a decrease in grain yield and in most of yield component traits. In the WI(RICLs-3A) mapping population the major grain yield QTL (*QGyld.neb.3A.1*) detected in the combined analysis by itself explained 19% of the phenotypic variance and the substitution of a CNN allele for a WI allele decreased grain yield by 87 kg ha^{-1} (Table 4). In Campbell et al. (2003), this grain yield QTL detected in the combined analysis explained 28% of the phenotypic variance and the substitution of a WI allele for a CNN allele increased grain yield by 66 kg ha^{-1}. The detection of yield-related QTLs in three separate studies in CNN(RICLs-3A) (M. Liakat Ali, personal communication; Campbell et al., 2003; Shah et al.,1999b) and in the current study using WI(RICLs-3A) strongly supports the hypothesis that the WI alleles at these clusters of QTLs will likely make an important contribution to grain yield of elite lines of hard winter wheat. Further investigations and additional RICLs were needed to dissect and precisely map the position and expression of *Qyld.neb-3A.1* under different field conditions because the ability to detect genetic loci for grain yield is highly influenced by genotype, environment and their interactions. The minor differences in the QTL locations for each of the traits reported among the different RICLs-3A studies might be due to the differences in the type of markers used, genotype (because of the change in the background chromosome in the current study), the environment, the number of replications and genotype/environment interactions. The results obtained from the previous and the current RICLs-3A studies helped us to better understand the inheritance of the complex grain yield trait in winter wheat. The valuable information gained will be used to maximize yield via selection for yield components. Overall, the identified QTLs or genomic regions associated with grain yield and yield-related traits will be promising candidates for future marker assisted breeding in improving the yield potential of bread wheat. Also, additional work such as fine-mapping and cloning the QTLs for grain yield and yield-related traits will facilitate the utilization of these traits in breeding programs.

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LISTS OF TABLES

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Table 1. Summary of agronomic traits evaluated in the WI(RICLs-3A) doubled haploid mapping population.

Trait name	Method of Measurement
Anthesis date	Days after 01/01. Visually estimated as the date when 50% of the spikes in a plot had extruded anthers
Plant height	Average plant height measured from the soil surface to the tip of the spike, excluding awns (cm)
Grain yield	Weight of grain harvested per unit area (kg ha^{-1})
Grain volume weight	Measured in $kghL^{-1}$ with Seedburo volumetric scale
Thousand kernel weight	Ten random spikes harvested from four rows and threshed to determine the weight of a 1000 kernel sample (g)
Kernel number per spike	Ten random spikes harvested from four rows and threshed to determine the kernel number per spike
Kernel number per square meter	Estimated by dividing plot grain yield by kernel weight
Spike number per square meter	Estimated by dividing plot grain yield by kernels per spike multiplied by kernel weight

Table 2. Means, standard errors (SE), range, standard deviation (SD), and heritability estimates (h^2) of grain yield (GYLD), 1000-kernel weight (TKW), grain volume weight (GVW), kernels per spike (KPS), kernels per square meter (KPSM), spikes per square meter (SPSM), plant height (PHT), and anthesis date (AD) evaluated in the WI(RICLs-3A) mapping population and its parents in six replicated trials in Nebraska environments during 2008 and 2009.

		Parents				WI(RICLs-3A) §			
Trait	Environment	WI	WI(CNN3A) †	Difference‡	SE	Mean	Range	SD	h^{2}¶
GYLD	Lincoln 2008	2797	2188	609	346	2611	1574-3629	471	0.74 (0.05)
	North Platte 2008	4800	4378	422	252	4285	2345-4903	355	0.77 (0.05)
	Lincoln 2009	4148	3500	647	264	3932	3333-4592	307	0.65 (0.07)
	Mead 2009	4074	3511	563	288	3455	2477-4388	365	0.71 (0.06)
	North Platte 2009	3519	3062	457	211	3438	2664-3931	244	0.65 (0.07)
	Sidney 2009	3813	3285	528	180	3585	2913-4058	206	0.67 (0.07)
	Combined	3863	3319	544	172	3552	2665-3910	200	0.66 (0.06)
TKW	Lincoln 2008	32.8	33.9	-1.1	2.10	32.5	26.9-37.0	1.9	0.37 (0.12)
	North Platte 2008	38.5	38.5	0.0	1.11	38.6	34.4-41.1	1.3	0.67 (0.06)
	Lincoln 2009	38.0	39.6	-1.7	1.37	38.4	34.3-41.5	1.2	0.37 (0.12)
	Mead 2009	39.4	37.1	2.2	1.59	38.3	32.3-41.4	1.6	0.57 (0.08)
	North Platte 2009	31.6	31.8	-0.2	1.92	32.5	28.7-35.0	1.4	0.27 (0.14)
	Sidney 2009	34.2	35.7	-1.4	1.22	34.9	31.8-37.3	1.2	0.56 (0.09)
	Combined	35.7	36.1	-0.4	0.74	35.9	32.8-38.0	0.9	0.72 (0.05)
KPS	Lincoln 2008	26.2	22.2	4.0	2.12	22.4	17.7-28.1	2.0	0.46 (0.10)
	North Platte 2008	21.7	23.4	-1.7	1.59	22.6	19.7-25.9	1.3	0.25 (0.15)
	Lincoln 2009	32.7	34.9	-2.2	2.10	33.6	28.0-39.4	2.2	0.54 (0.09)
	Mead 2009	32.2	31.1	1.2	1.91	32.1	28.5-36.7	1.7	0.40 (0.11)
	North Platte 2009	25.4	22.7	2.7	1.65	23.2	19.6-27.2	1.5	0.34 (0.13)
	Sidney 2009	19.5	21.9	-2.3	1.80	23.3	20.6-26.8	1.4	0.18 (0.17)
	Combined	26.3	26.0	0.3	0.94	26.2	24.3-28.7	0.9	0.47 (0.01)
KPSM	Lincoln 2008	8505	6698	1807	1212	8071	5142-12097	1502	0.68 (0.06)
	North Platte 2008	12472	11317	1155	764	11103	6864-13019	830	0.61 (0.07)
	Lincoln 2009	10965	8854	2112	739	10214	8189-12417	811	0.59 (0.07)

Trait	Environment	Parents				WI(RICLs-3A) §			
		WI	WI(CNN3A) †	Difference‡	SE	Mean	Range	SD	h2¶
	Mead 2009	10465	9472	993	830	9020	6848-11379	855	0.57 (0.08)
	North Platte 2009	11131	9664	1467	924	10648	8150.-12573	819	0.46 (0.12)
	Sidney 2009	11148	9199	1949	630	10308	8489-11817	608	0.57 (0.09)
	Combined	10797	9196	1601	505	9899	7541-10895	497	0.53 (0.08)
SPSM	Lincoln 2008	331	302	29	69	368	195-565	76.8	0.60 (0.08)
	North Platte 2008	578	494	85	52	495	323-616	47.1	0.39 (0.11)
	Lincoln 2009	337	254	84	31	307	245-423	31.2	0.53 (0.09)
	Mead 2009	327	314	13	28	283	191-377	30.7	0.60 (0.08)
	North Platte 2009	432	418	14	49	464	376-555	45.0	0.40 (0.13)
	Sidney 2009	576	427	149	47	446	338-530	36.0	0.28 (0.15)
	Combined	432	368	64	24	394	283-443	25.6	0.57 (0.08)
GVW	Lincoln 2008	74.6	72.7	1.9	1	73	71.0-75.0	0.8	0.58 (0.08)
	North Platte 2008	76.8	74.9	1.9	1.0	75.8	69.9-79.5	1.1	0.60 (0.08)
	Lincoln 2009	82.1	80.6	1.5	0.5	81.6	79.2-82.6	0.6	0.73 (0.05)
	Mead 2009	74.8	73.5	1.4	0.9	74.6	70.1-76.1	1.0	0.62 (0.08)
	North Platte 2009	74.2	73.8	0.4	0.7	74.3	71.8-75.7	0.7	0.54 (0.09)
	Sidney 2009	75.6	74.1	1.5	0.5	76.1	74.3-77.6	0.7	0.77 (0.05)
	Combined	76.3	75.0	1.4	0.5	75.9	73.4-76.8	0.5	0.73 (0.05)
PHT	Lincoln 2008	106.6	116.8	-10.2	1.9	107.5	96.0-116.6	4.4	0.92 (0.02)
	North Platte 2008	118.3	123.5	-5.3	2.4	117.0	104.0-123.3	3.3	0.72 (0.05)
	Lincoln 2009	83.9	98.0	-14.1	2.2	90.0	82.6-105.0	4.6	0.90 (0.02)
	Mead 2009	96.8	101.4	-4.6	2.4	99.7	89.2-110.0	4.5	0.86 (0.02)
	North Platte 2009	113.0	123.7	-10.8	2.2	117.5	109.5-127.6	3.8	0.68 (0.06)
	Sidney 2009	94.1	100.5	-6.4	2.2	94.1	75.1-104.4	4.3	0.88 (0.02)
	Combined	102.1	110.6	-8.4	1.9	104.4	97.7-110.3	2.9	0.79 (0.04)
AD#	Lincoln 2008	152.9	154.8	-2.0	0.5	152.7	150.0-155.4	1.26	0.94 (0.01)
	North Platte 2008	153.5	155.5	-2.1	0.5	154.0	152.0-156.8	0.92	0.87 (0.02)

Trait	Environment	Parents				WI(RICLs-3A) §			
		WI	WI(CNN3A) †	Difference‡	SE	Mean	Range	SD	h^2¶
	Lincoln 2009	142.8	144.5	-1.7	0.5	143.3	140.2-145.0	1.05	0.91 (0.02)
	Mead 2009	144.8	147.5	-2.7	0.5	144.9	141.9-146.7	1.25	0.94 (0.01)
	North Platte 2009	145.6	148.3	-2.7	0.4	147.2	145.2-149.9	0.88	0.92 (0.02)
	Combined	148.1	150.2	-2.1	0.4	148.4	146.2-150.3	0.95	0.93 (0.10)

† WI(CNN3A) = Wichita substitution line, chromosome 3A of cultivar Wichita replaced with chromosome 3A of Cheyenne.
‡ Differences of least squares means for the two parents. Note: -ve means WI(CNN3A) has greater mean.
§ WI(RICLs-3A) = recombinant inbred chromosome lines for the 3A chromosome under Wichita background.
¶ Values in parenthesis are standard errors for the h^2 (calculated at α= 0.05).
# AD was evaluated only in five environments.

Table 3. Pearson correlation coefficients among grain yield (GYLD), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), spikes per square meter (SPSM), grain volume weight (GVW), plant height (PHT), and anthesis date (AD) evaluated in 90 WI(RICLs-3A) mapping population in six replicated trials in Nebraska environments during 2008 and 2009.

n=90	TKW	KPS	KPSM	SPSM	GVW	PHT	AD‡
GYLD	0.52***	-0.13ns†	0.89***	0.77***	0.65***	-0.20*	-0.23*
TKW		-0.07ns	0.09ns	0.12ns	0.52***	-0.18ns	-0.20*
KPS			-0.14ns	-0.60***	-0.13ns	0.23*	0.39***
KPSM				0.85***	0.48***	-0.18ns	-0.20*
SPSM					0.44***	-0.30**	-0.36***
GVW						-0.31**	-0.15ns
PHT							0.58***

*Probability of correlation different from zero is <0.05.
** Probability of correlation different from zero is <0.01
***Probability of correlation different from zero is <0.001.
†ns, not significant.
‡ AD was evaluated only in five environments.

Table 4. Quantitative trait loci (QTL) for grain yield (GYLD), 1000-kernel weight (TKW), grain volume weight (GVW), kernels per spike (KPS), kernels per square meter (KPSM), spikes per square meter (SPSM), plant height (PHT), and anthesis date (AD) evaluated in WI(RICLs-3A) mapping population in six replicated experiments in Nebraska environments during 2008 and 2009.

QTL	Trait	Environment	LOD† score	Flanking markers	Peak position (cM)	Most significant marker	R^2 (%)‡	Additive effect§
QYld.neb-3A.1	GYLD	Lincoln 2008	2.8	*Xbarc86-Xwmc388.1*	38.0	*Xwmc640*	13	-173.00
QYld.neb-3A.1	GYLD	North Platte 2009	3.4	*Xstm6352-Xcfa2193*	58.8	*Xbarc1060*	17	-101.00
QYld.neb-3A.1	GYLD	Combined	4.0	*Xbarc86-Xstm6352*	38.0	*Xwmc640*	19	-86.60
QYld.neb-3A.2	GYLD	Combined	3.6	*Xstm6352-Xhbg284*	51.1	*Xhbg284*	17	-82.40
QTkw.neb-3A.1	TKW	Lincoln 2008	4.1	*Xbarc67-Xstm6352*	41.6	*Xwmc388.1*	19	-0.80
QTkw.neb-3A.2	TKW	North Platte 2008	3.4	*Xhbg284-Xcfa2193*	61.0	*Xgwm497*	16	-0.53
QTkw.neb-3A.1	TKW	Combined	4.9	*Xbarc86-Xwmc664*	38.0	*Xwmc640*	21	-0.43
QTkw.neb-3A.2	TKW	Combined	4.3	*Xstm6352-Xhbg284*	51.1	*Xhbg284*	19	-0.41
QKps.neb-3A	KPS	Sidney 2009	2.8	*Xwmc640-Xbarc356*	39.4	*Xwmc664*	13	0.52
QSsm.neb-3A	SPSM	North Platte 2009	3.4	*Xgwm218-Xwmc640*	35.9	*Xbarc86*	16	-18.03
QSsm.neb-3A	SPSM	Combined	2.7	*Xbarc86-Xbarc356*	38.0	*Xwmc640*	12	-9.20
QGvw.neb-3A.1	GVW	Lincoln 2008	8.9	*Xwmc664-Xstm6352*	42.6	*Xwmc388.1*	39	-0.52
QGvw.neb-3A.1	GVW	North Platte 2008	3.8	*Xwmc664-Xstm6352*	41.6	*Xwmc388.1*	18	-0.45
QGvw.neb-3A.1	GVW	Lincoln 2009	13.5	*Xbarc86-Xstm6352*	41.6	*Xwmc388.1*	49	-0.44
QGvw.neb-3A.1	GVW	Mead 2009	7.2	*Xgwm218-Xwmc640*	35.7	*Xbarc86*	31	-0.54
QGvw.neb-3A.1	GVW	North Platte 2009	8.2	*Xbarc86-Xstm6352*	36.9	*Xwmc640*	35	-0.42
QGvw.neb-3A.2	GVW	North Platte 2009	7.6	*Xstm6352-Xwmc428*	51.1	*Xhbg284*	32	-0.40
QGvw.neb-3A.1	GVW	Combined	14.9	*Xbarc86-Xstm6352*	41.6	*Xwmc388.1*	53	-0.39
QPht.neb-3A.1	PHT	North Platte 2008	5.2	*Xgwm218-Xwmc664*	38.0	*Xwmc640*	23	1.61
QPht.neb-3A.2	PHT	North Platte 2008	3.9	*Xstm6352-Xhbg284*	51.1	*Xhbg284*	19	1.45
QPht.neb-3A.2	PHT	Lincoln 2009	3.9	*Xstm6352-Xhbg227*	56.8	*Xbarc1060*	18	1.96
QPht.neb-3A.2	PHT	Mead 2009	3.1	*Xhbg284-Xhbg227*	55.6	*Xwmc428*	15	1.76
QPht.neb-3A.1	PHT	North Platte 2009	5.5	*Xgwm218-Xwmc664*	39.0	*Xwmc640*	25	1.87
QPht.neb-3A.2	PHT	Sidney 2009	5.3	*Xhbg284-Xhbg227*	57.8	*Xbarc1060*	26	2.20
QPht.neb-3A.1	PHT	Combined	7.1	*Xbarc86-Xbarc67*	38.0	*Xwmc640*	31	1.62

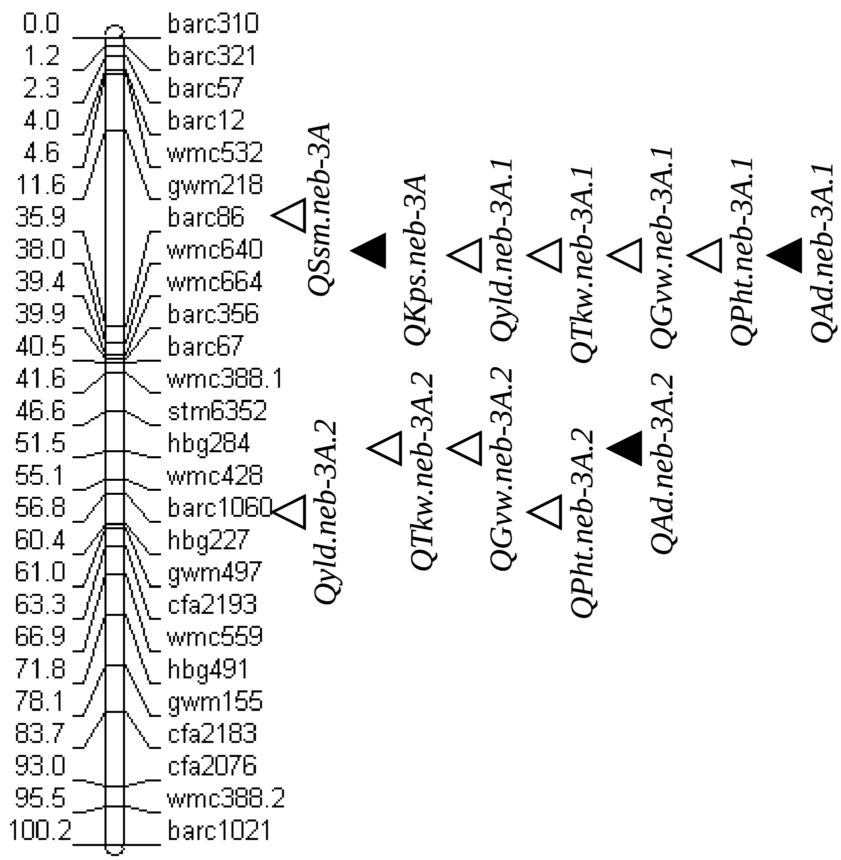
QTL	Trait	Environment	LOD† score	Flanking markers	Peak position (cM)	Most significant marker	R^2 (%)‡	Additive effect§
QPht.neb-3A.2	PHT	Combined	6.3	*Xstm6352-Xhbg284*	50.1	*Xhbg284*	28	1.55
QAdt.neb-3A.1	AD	North Platte 2008	5.1	*Xbarc86-Xwmc388.1*	38.0	*Xwmc640*	23	0.45
QAdt.neb-3A.2	AD	North Platte 2008	3.8	*Xstm6352-Xhbg284*	51.1	*Xhbg284*	19	0.39

† LOD, logarithm of odds.

‡ The phenotypic variation explained by the QTL.

§ Additive effect of a single Wichita allele, equivalent to the mean of RICLs-3A homozygous for Wichita alleles minus the mean of RICLs-3A homozygous for Cheyenne alleles divided by 2.

Figure 1. Position of QTLs detected in a WI x WI(CNN3A) derived doubled haploid mapping population, tested in six environments. Locus marker names are shown on the right side of the chromosome and values to the left of the chromosome indicate the genetic distance (cM). QTL pick positions are shown with open and closed triangles. The nine open triangles indicate those QTLs detected across environments while the three closed triangles indicate QTLs detected only in individual environments. Quantitative trait loci are labeled with trait abbreviations and the QTL number for each trait.



LIST OF APPENDICES TABLES

Appendix 1. Monthly mean temperature and total precipitation (precip) for Lincoln, Mead, North Platte, and Sidney during the 2008 and 2009 cropping season.

		Lincoln		Mead		North Platte		Sidney	
Year	Month	Mean Temp	Total Precip	Mean Temp	Total Precip	Mean Temp	Total Precip	Mean Temp	Total Precip
2007	Sep	20.2	72			18.3	34		
2007	Oct	15.2	114	14.6	116	12.3	30	11.6	12
2007	Nov	4.9	1	4.1	-	4.3	1	3.8	0
2007	Dec	-3.9	53	-5.8	-	-5.7	21	-6.1	8
2008	Jan	-4.8	11	-7.2	-	-4.5	1	-5.8	0
2008	Feb	-3.1	14	-4.7	-	-0.8	3	-0.9	1
2008	Mar	4.2	29	3.2	-	3.4	23	3.6	11
2008	Apr	9.4	97	9.1	101	8.1	93	7.5	36
2008	May	16.9	105	16.3	142	14.0	189	12.7	68
2008	Jun	24.1	218	23.4	287	20.1	71	18.9	77
2008	Jul	27.3	91	25.9	110	25.8	57	25.1	49
Total			805		757		522		262
2008	Sep	19.9	104	19.0	96	18.0	34	16.7	47
2008	Oct	13.5	122	13.0	115	10.4	121	9.9	26
2008	Nov	5.1	31	4.4	30	4.0	9	4.9	16
2008	Dec	-4.6	20	-5.6	20	-5.3	6	-5.0	2
2009	Jan	-4.1	10	-5.3	0	-2.1	8	-0.8	4
2009	Feb	-0.5	16	-1.3	0	-0.5	24	0.4	10
2009	Mar	5.2	5	4.4	5	3.6	8	3.8	3
2009	Apr	11.0	39	10.3	31	9.0	72	7.6	70
2009	May	18.9	30	18.3	41	15.8	71	14.9	51
2009	Jun	23.7	157	23.0	139	20.4	78	19.8	192
2009	Jul	23.9	47	22.6	71	22.8	127	23.7	88
Total			580		547		559		509

Appendix 2. Pearson correlation coefficients among grain yield (GYLD), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), spikes per square meter (SPSM), grain volume weight (GVW), plant height (PHT), and anthesis date (AD) evaluated in 90 WI(RICLs-3A) mapping population in six replicated trials in Nebraska environments during 2008 and 2009.

Lincoln 2008

n=90	TKW	KPS	KPSM	SPSM	GVW	PHT	AD
GYLD	0.25*	0.12ns†	0.93***	0.76***	0.15ns	-0.29**	-0.57***
TKW		0.60***	-0.08ns	-0.32**	0.44***	-0.15ns	-0.10ns
KPS			-0.07ns	-0.48***	0.32**	-0.28**	-0.11ns
KPSM				0.90***	0.01ns	-0.22*	-0.55***
SPSM					-0.13ns	-0.08ns	-0.42***
GVW						0.05ns	0.16ns
PHT							0.39***

*Probability of correlation different from zero is <0.05.
** Probability of correlation different from zero is <0.01
***Probability of correlation different from zero is <0.001.
†ns, not significant.

North Platte 2008

n=90	TKW	KPS	KPSM	SPSM	GVW	PHT	AD
GYLD	0.47***	-0.07ns	0.92***	0.76***	0.55***	0.43***	-0.09ns
TKW		-0.09ns	0.09ns	0.12ns	0.45***	0.10ns	-0.26**
KPS			-0.02ns	-0.61***	-0.04ns	0.25*	0.43***
KPSM				0.80***	0.45***	0.46***	0.01ns
SPSM					0.38***	0.22*	-0.23*
GVW						0.17ns	-0.25*
PHT							0.48***

Lincoln 2009

n=90	TKW	KPS	KPSM	SPSM	GVW	PHT	AD
GYLD	0.21ns	0.11ns	0.91***	0.64***	0.30**	-0.07ns	0.31**
TKW		0.15ns	-0.21*	-0.26**	0.31**	0.04ns	-0.07ns
KPS			0.03ns	-0.60***	-0.14ns	-0.07ns	0.33**
KPSM				0.77***	0.15ns	-0.05ns	0.33**
SPSM					0.20ns	-0.01ns	0.07ns
GVW						-0.23*	-0.01ns
PHT							-0.19ns

Appendix 2. Cont'd

Mead 2009

n=90	TKW	KPS	KPSM	SPSM	GVW	PHT	AD
GYLD	0.46^{***}	0.05^{ns}	0.92^{***}	0.77^{***}	0.59^{***}	0.01^{ns}	-0.30^{**}
TKW		0.02^{ns}	0.09^{ns}	0.08^{ns}	0.58^{***}	-0.20^{ns}	-0.36^{***}
KPS			0.03^{ns}	-0.47^{***}	-0.07^{ns}	0.10^{ns}	0.16^{ns}
KPSM				0.86^{***}	0.44^{***}	0.13^{ns}	-0.16^{ns}
SPSM					0.43^{***}	0.08^{ns}	-0.21^{*}
GVW						-0.22^{*}	-0.23^{*}
PHT							0.43^{***}

North Platte 2009

n=90	TKW	KPS	KPSM	SPSM	GVW	PHT	AD
GYLD	0.19^{ns}	0.03^{ns}	0.80^{***}	0.64^{***}	0.46^{***}	-0.03^{ns}	-0.11^{ns}
TKW		-0.09^{ns}	-0.43^{***}	-0.28^{**}	0.24^{*}	0.01^{ns}	-0.16^{ns}
KPS			0.10^{ns}	-0.56^{***}	-0.16^{ns}	0.29^{**}	0.16^{ns}
KPSM				0.75^{***}	0.29^{**}	-0.05^{ns}	-0.03^{ns}
SPSM					0.33^{**}	-0.22^{*}	-0.13^{ns}
GVW						-0.48^{***}	-0.46^{***}
PHT							0.60^{***}

Sidney 2009

n=90	TKW	KPS	KPSM	SPSM	GVW	PHT
GYLD	0.23^{*}	0.20^{ns}	0.82^{***}	0.40^{***}	0.11^{ns}	0.08^{ns}
TKW		0.24^{*}	-0.35^{***}	-0.45^{***}	0.40^{***}	0.23^{*}
KPS			0.07^{ns}	-0.70^{***}	0.10^{ns}	0.27^{**}
KPSM				0.64^{***}	-0.14^{ns}	-0.05^{ns}
SPSM					-0.17^{ns}	-0.23^{*}
GVW						0.32^{**}

Appendix 3. Least square means of lines with WI 3A, CNN 3A, and checks for grain yield (GYLD), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), spikes per square meter (SPSM), grain volume weight (GVW), plant height (PHT), and anthesis date (AD) evaluated in six replicated trials (n=1620) in Nebraska environments during 2008 and 2009.

	WI 3A†				CNN 3A*				Checks				
Trait	WI	CNN(WI3A)‡	WI(CNN6A)§	Mean	WI(CNN3A)¶	CNN	CNN(WI6A)#	Mean	Pronghorn	Jagger	Overland	Goodstreakk	Mean
GYLD	3863	3939	3170	3657	3319	3476	3522	3439	4776	4925	4770	5118	4938
TKW	35.7	33.1	36.7	35.2	36.1	31.6	36.6	34.8	35.5	34.2	33.1	34.0	33.8
KPS	26.3	27.6	25.1	26.3	26.0	26.8	26.7	26.5	28.5	31.8	32.2	31.1	31.7
KPSM	10797	11788	8583	10390	9196	11781	9614	10197	13491	14548	14467	15139	14718
SPMS	432	435	356	407	368	461	386	405	486	478	464	505	482
GVW	76.3	76.5	75.6	76.1	75.0	76.5	76.5	76.0	78.0	77.4	76.5	77.7	77.2
PH	102.1	101.6	104.7	102.8	110.6	109.7	106.2	108.2	101.1	87.1	91.7	105.6	94.8
AD	148.1	150.8	150.1	149.6	150.2	151.8	149.9	150.6	149.0	146.7	150.2	150.1	149.0

WI = Wichita; CNN = Cheyenne

WI 3A† = Wichita chromosome 3A; CNN(WI3A)‡ = Cheyenne with Wichita 3A; WI(CNN6A)§ = Wichita with Cheyenne 6A; CNN 3A* = Cheyenne chromosome 3A; WI(CNN3A)¶ = Wichita with Cheyenne 3A; CNN(WI6A)# = Cheyenne with Wichita 6A;

Appendix 4. Mean squares, least square means and coefficient of variation (CV) for grain yield (GYLD), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), spikes per square meter (SPSM), grain volume weight (GVW), plant height (PHT), and anthesis date (AD) evaluated in 90 WI(RICLs-3A) mapping population in six replicated trials in Nebraska environments and for the individual environments grown during 2008 and 2009.

Combined

	GYLD		TKW		KPS		KPSM		SPSM		GVW		PHT		AD	
Source	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Environment (E)	5	101501807	5	2641.7	5	8019.5	5	394542050	5	2297418	5	2553.7	5	39325.0	4	6816.2
Rep x Iblock(E)	354	283297	354	7.1	354	8.6	354	2577992	354	6679	354	1.8	354	15.3	295	0.9
Genotype (G)	99	1267673	99	15.5	99	20.9	99	12553854	99	13284	99	5.0	99	166.4	99	11.9
G x E	495	219244	495	4.4	495	7.0	495	1929532	495	4598	495	1.5	495	27.5	396	0.8
Residual	836	89482	845	3.5	845	4.8	835	1003861	835	3127	843	0.7	846	6.6	705	0.3
Mean 100 entry		3612		35.8		26.4		10108		398.1		76.0		104.1		148.5
Mean WI(RICLs-3A)		3556		35.9		26.2		9904		393.8		75.9		104.3		148.4
Mean WI(CNN3A)		3319		36.1		26.0		9196		368.4		75.0		110.6		150.2
Mean WI		3863		35.7		26.3		10797		431.9		76.3		102.1		148.1
CV (%)		8.3		5.2		8.3		9.9		14.0		1.1		2.5		0.4

Note: Mean squares of genotype and genotype x environment interactions for all traits are significant at 0.01 levels of probability; RMSE=root

Lincoln 2008

	GYLD		TKW		KPS		KPSM		SPSM		GVW		PHT		AD	
Source	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Iblock(Rep)	59	374089	59	8.7	59	11.6	59	4249474	59	12541	59	1.6	59	6.3	59	1.2
Genotype	99	586641	99	10.0	99	11.4	99	6805159	99	13424	99	2.2	99	61.9	99	4.0
Residual	140	158410	141	6.2	141	6.1	140	1944226	140	6317	140	0.9	141	5.2	141	0.3
Mean 100 entry		2639		32.3		22.8		8229		367		73.2		107.1		152.9
CV (%)		15.1		7.7		10.8		16.9		21.7		1.3		2.1		0.4

Note: for all traits the mean squares of genotype are significant at 0.01 levels of probability

Appendix 4. Cont'd

Lincoln 2009

	GYLD		TKW		KPS		KPSM		SPSM		GVW		PHT		AD	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Iblock(Rep)	59	329095	59	3.8	59	11.3	59	1899407	59	3216	59	0.7	59	21.0	59	0.9
Genotype	99	454920	99	4.5	99	14.1	99	2949303	99	2844	99	1.2	99	46.4	99	3.0
Residual	139	89610	141	2.7	141	6.0	139	721626	139	1264	140	0.3	141	6.4	141	0.3
Mean 100 entry		4029		38.5		33.8		10464		312		81.5		90.1		143.4
CV (%)		7.4		4.2		7.3		8.1		11.4		0.7		2.8		0.4

Note: for all traits the mean squares of genotype are significant at 0.01 levels of probability

Mead 2009

	GYLD		TKW		KPS		KPSM		SPSM		GVW		PHT		AD	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Iblock(Rep)	59	341953	59	5.7	59	6.2	59	2268518	59	3008	59	2.2	59	17.0	59	1.0
Genotype	99	369734	99	8.0	99	8.6	99	2841426	99	2701	99	2.7	99	41.6	99	4.1
Residual	134	106390	141	3.5	141	5.3	134	904148	134	1049	141	1.0	141	7.8	141	0.3
Mean 100 entry		3533.24		38.1		32.3		9284		288		74.6		99.6		145.0
CV (%)		9.2		4.9		7.1		10.2		11.2		1.3		2.8		0.4

Note: for all traits the mean squares of genotype are significant at 0.01 levels of probability

North Platte 2008

	GYLD		TKW		KPS		KPSM		SPSM		GVW		PHT		AD	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Iblock(Rep)	59	228012	59	2.5	59	6.7	59	1509788	59	7042	59	4.1	59	11.8	59	0.5
Genotype	99	529759	99	6.6	99	7.3	99	4556712	99	7403	99	3.0	99	40.2	99	2.3
Residual	141	83645	141	1.7	141	3.4	141	796470	141	3690	141	1.3	141	7.9	141	0.3
Mean 100 entry		4360.63		38.4		22.8		11391		503		75.9		116.5		154.1
CV (%)		6.6		3.4		8.1		7.8		12.1		1.5		2.4		0.3

Note: for all traits the mean squares of genotype are significant at 0.01 levels of probability

Appendix 4. Cont'd

North Platte 2009

	GYLD		TKW		KPS		KPSM		SPSM		GVW		PHT		AD	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Iblock(Rep)	59	244842	59	11.4	59	8.0	59	3584523	59	7027	59	1.7	59	19.0	59	0.8
Genotype	99	321563	99	6.2	99	8.1	99	4027798	99	5426	99	1.5	99	63.9	99	2.1
Residual	143	56615	142	5.0	142	3.6	142	1101908	142	3201	142	0.7	143	12.6	141	0.2
Mean 100 entry		3494.16		32.4		23.3		10850		467		74.4		117.1		147.3
CV (%)		6.8		6.9		8.2		9.7		12.1		1.1		3.0		0.3

Note: for all traits the mean squares of genotype are significant at 0.01 levels of probability

Sidney 2009

	GYLD		TKW		KPS		KPSM		SPSM		GVW		PHT	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Iblock(Rep)	59	178945	59	10.8	59	7.5	59	1948451	59	7139	59	0.5	59	23.9
Genotype	99	165459	99	3.7	99	7.0	99	1814952	99	5081	99	2.5	99	52.7
Residual	139	41769	139	1.9	139	4.5	139	513051	139	2974	139	0.3	139	6.1
Mean 100 entry		3614.73		34.8		23.4		10429		451		76.3		94.0
CV (%)		5.7		3.9		9.1		6.9		12.1		0.8		2.6

Note: for all traits the mean squares of genotype are significant at 0.01 levels of probability

Appendix 5. Description of the primer sets used in the WI(RICLs-3A) mapping population.

No	Locus name	**Size**	**Chromosome location**	**Foreword primer**	**Reverse primer**	**Annealing Temp**
1	*Xbarc1021*	*279*	*3A*	5' GGA AGG ACC TGA CTG ACT GCA TCT G 3'	5' GCG ATC ACA ACC ATT CTT TTT AAC TA 3'	55
2	*Xbarc1044*	*178*	*3A, 3D*	5' TTG TGG TGT GTG TGG TTC AGT CT 3'	5' GCG ACA AGA CGA ACT ATT TAC TAC TG 3'	55
3	*Xbarc1060*	*241*	3A	5' GCG TCT ATT TTT GCC ATT TCC ATT CA 3'	5' GCG ATG TTC TGT AGT TCT TAG TGT TCT TT 3'	55
4	*Xbarc12*	200	3A	5' CGACAGAGTGATCACCCAAATATAA 3'	5' CATCGGTCTAATTGTCAATGTA 3'	52°
5	*Xbarc310*	*199*	3A	5' GGG CGG CGC ATG TGC ACC TA 3'	5' GCG TGG AAG CGA CTA AAT CAA CT 3'	57
6	*Xbarc321*	*178*	*3A; 3D*	5' TGC ACT TCC CAC AAC ACA TC 3'	5' TTG CCA CGT AGG TGA TTT ATG A 3'	52
7	*Xbarc324*	*247*	3A	5' CCA ATT CTG CCC ATA GGT GA 3'	5' GAG GAA ATA AGA TTC AGC CAA CTG 3'	50
8	*Xbarc356*	*150*	3A	5' CGC TAG AGC TGT TTG AGG GGA GGA G 3'	5' CGC ATG TAG GGG GAG GCT TCT TTT 3'	57
9	*Xbarc57*	*252*	3A	5' GCGACCACCTCAGCCAACTTATTATGT 3'	5' GCGGGGAGGCACATTCATAGGAGT 3'	55
10	*Xbarc67*	*104*	3A	5' GCGGCATTTACATTTCAGATAGA 3'	5' TGTGCCTGATTGTAGTAACGTATGTA 3'	52
11	*Xbarc86*	*142*	3A	5' GCG CTT GCT TTA TTA GTA GGT AT 3'	5' TCC CAC GAT AGT ATT TGA TGT T 3'	52
12	*Xcfa2076*	*172*	*3A; 3D*	5' CGAAAAACCATGATCGACAG 3'	5' ACCTGTCCAGCTAGCCTCCA 3'	60
13	*Xcfa2183*	*168*	3A	5' CGAAAAACCATGATCGACAG 3'	5' ACCTGTCCAGCTAGCCTCCA 3'	52
14	*Xcfa2193*	*195*	3A	5' ACATGTGATGTGCGGTCATT 3'	5' TCCTCAGAACCCCATTCTTG 3'	60
15	*Xcfa2262*	*172*	*2D, 3A*	5' ACAATGTGGAGATGGCACAA 3'	5' TACCAGCTGCACTTCCATTG 3'	60
16	*Xgwm155*	*143/127*	*3A, 1D*	5' CAATCATTTCCCCCTCCC 3'	5' AATCATTGGAAATCCATATGCC 3'	60
17	*Xgwm218*	*145*	3A	5' CGGCAAACGGATATCGAC 3'	5' AACAGTAACTCTCGCCATAGCC 3'	55
18	*Xgwm497*	*147/137/103*	*1A, 2A, 3A, 3D, 5B*	5' GTAGTGAAGACAAGGGCATT 3'	5' CCGAAAGTTGGGTGATATAC 3'	55
19	*Xgwm666.1*	*114*	*1A, 3A, 5A, 7A*	5' GCACCCACATCTTCGACC 3'	5' TGCTGCTGGTCTCTGTGC 3'	60
20	*Xgwm666.2*	150	*1A, 3A, 5A, 7A*	5' GCACCCACATCTTCGACC 3'	5' TGCTGCTGGTCTCTGTGC 3'	60
21	*Xhbg227*	*222*	*3A*	5' GGGTACCTGACTGCTAAGGGATCT 3'	5' TCGCCTCCATGTAGGACTCTGATA 3'	58
22	*Xhbg284*	*160*	*3A*	5' CACTACTGCAGCACCAAGTAT 3'	5' AGACGATCGGATTGCATCTATG 3'	58
23	*Xhbg491*	*274*	*3A*	5' TTCAACATCGTCTCAGTCCTAGC 3'	5' CAGGAACTATCATAGGACTCCACAG 3'	55
24	*Xpsp3047*	*184*	*3A*	5' CCGTTCATAGGCCAATTTCG 3'	5' TCTGCAACATTCCCCAACAG 3'	61
25	*Xstm635acag*		3A	5' TAA CGC TTC ACT TCC GTT TTG GTC A 3'	5' GGCAGCAGACACACACACACACAGAGAGAG 3'	60
26	*Xstm99tctg*		3A	5' ATG CAG CCC GTT CTA GAA ATG T 3'	5' GGCAGCAGTCTCTCTCTCTCTGTGTGTG 3'	60
27	*Xwmc11*	*184/240/177*	*3A, 1A*	5' TTGTGATCCTGGTTGTGTTGTGA 3'	5' CACCCAGCCGTTATATATGTTGA 3'	61
28	*Xwmc388.1*	*161*	*3A, 5A, 6A, 6B, 7A*	5' TGTGCGGAATGATTCAATCTGT 3'	5' GGCCATTAGACTGCAATGGTTT 3'	61
29	*Xwmc388.2*	*340*	*3A, 5A, 6A, 6B, 7A*	5' TGTGCGGAATGATTCAATCTGT 3'	5' GGCCATTAGACTGCAATGGTTT 3'	61
30	*Xwmc428*	*257*		5' TTAATCCTAGCCGTCCCTTTTT 3'	5' CGACCTTCGTTGGTTATTTGTG 3'	51
31	*Xwmc489*	*176/270*	*1D, 2B, 3A, 4D, 5A, 7D*	5' CGAAGGATTTGTGATGTGAGTA 3'	5' GGACAACATCATAGAGAAGGAA 3'	51
32	*Xwmc532*	*176*	3A	5' GATACATCAAGATCGTGCCAAA 3'	5' GGGAGAAATCATTAACGAAGGG 3'	61
33	*Xwmc559*	*338*	3A	5' ACACCACGAATGATGTGCCA 3'	5' ACGACGCCATGTATGCAGAA 3'	61
34	*Xwmc640*	*180*	3A, 5B, 5D	5' AATTTATCTCGATCATGTGAGC 3'	5' TGAGTAGTTCCCTTAGGACCTT 3'	61
35	*Xwmc664*	*157*	3A	5' GGGCCAACAAATCCAAT 3'	5' TCTACTTCCTTCATCCACTCC 3'	61

Appendix 6. Field dataset for anthesis date (AD), plant height (PHT), grain yield (GYLD), grain volume weight (GVW), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), and spikes per square meter (SPSM), evaluated in WI(RICLs-3A) mapping population at Lincoln, NE during 2008 cropping season.

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	1	WI(RICL3A)-1	1	153	102	2351	73.0	36.5	24.0	6449	269
1	1	WI(RICL3A)-2	2	154	97	1541	71.3	28.5	20.3	5411	267
1	1	WI(RICL3A)-3	3	153	104	2065	73.6	32.2	25.1	6416	256
1	1	WI(RICL3A)-4	4	153	104	2035	72.2	32.8	22.5	6196	275
1	1	WI(RICL3A)-5	5	154	114	1981	72.0	34.0	25.1	5823	232
1	2	WI(RICL3A)-6	6	153	117	2072	71.5	31.1	23.9	6665	279
1	2	WI(RICL3A)-7	7	152	107	2974	74.4	36.7	23.2	8107	349
1	2	WI(RICL3A)-8	8	154	102	1413	73.8	33.6	23.6	4205	178
1	2	WI(RICL3A)-9	9	153	114	2123	72.5	33.2	24.8	6404	258
1	2	WI(RICL3A)-10	10	152	107	2069	73.3	35.4	26.3	5844	222
1	3	WI(RICL3A)-11	11	153	104	1547	74.2	32.2	24.6	4812	196
1	3	WI(RICL3A)-12	12	153	104	1887	73.5	34.1	28.3	5528	195
1	3	WI(RICL3A)-13	13	153	112	1574	73.5	32.8	24.0	4801	200
1	3	WI(RICL3A)-14	14	153	114	1847	71.7	30.3	20.0	6105	305
1	3	WI(RICL3A)-15	15	151	97	2731	71.2	30.4	26.4	8991	341
1	4	WI(RICL3A)-16	16	153	114	2994	72.6	28.5	18.4	10513	571
1	4	WI(RICL3A)-17	17	154	112	2839	72.9	28.6	23.9	9935	416
1	4	WI(RICL3A)-18	18	155	109	1756	73.4	27.3	16.4	6428	392
1	4	WI(RICL3A)-19	19	154	102	2779	72.9	27.3	25.8	10168	394
1	4	WI(RICL3A)-20	20	151	99	3189	72.2	32.6	23.2	9786	422
1	5	WI(RICL3A)-21	21	154	102	3317	72.9	32.5	28.1	10219	364
1	5	WI(RICL3A)-22	22	152	99	2980	72.6	30.2	24.2	9880	408
1	5	WI(RICL3A)-23	23	152	99	2752	71.1	30.8	24.3	8939	368
1	5	WI(RICL3A)-25	24	153	112	1978	73.4	30.4	24.6	6505	264
1	5	WI(RICL3A)-26	25	154	112	2055	71.1	30.3	25.5	6780	266
1	6	WI(RICL3A)-27	26	154	109	1887	72.1	28.0	18.9	6730	356
1	6	WI(RICL3A)-28	27	151	102	2321	72.0	34.5	28.2	6734	239
1	6	WI(RICL3A)-29	28	152	102	2903	71.7	30.8	21.3	9440	443
1	6	WI(RICL3A)-30	29	153	109	2119	73.1	29.6	19.9	7172	360
1	6	WI(RICL3A)-31	30	154	109	2832	71.5	25.1	21.7	11277	520
1	7	WI(RICL3A)-32	31	155	102	2701	73.6	31.6	25.6	8558	334
1	7	WI(RICL3A)-33	32	154	109	2782	72.7	28.6	23.1	9737	422
1	7	WI(RICL3A)-34	33	155	112	1554	72.7	27.2	21.6	5709	264
1	7	WI(RICL3A)-35	34	155	114	1682	73.5	32.1	24.7	5239	212
1	7	WI(RICL3A)-36	35	155	112	1833	72.1	32.2	22.7	5701	251
1	8	WI(RICL3A)-37	36	155	107	1816	70.9	34.9	23.6	5209	221
1	8	WI(RICL3A)-38	37	155	114	2082	72.9	31.1	19.5	6700	344
1	8	WI(RICL3A)-39	38	154	102	2368	73.8	35.6	25.5	6651	261
1	8	WI(RICL3A)-40	39	155	109	2358	74.4	31.0	23.0	7617	331
1	8	WI(RICL3A)-41	40	154	107	2563	75.2	31.7	23.5	8075	344
1	9	WI(RICL3A)-42	41	154	104	2230	73.9	33.4	22.0	6685	304
1	9	WI(RICL3A)-43	42	153	112	2641	73.0	36.8	25.3	7176	284
1	9	WI(RICL3A)-44	43	153	112	2503	73.3	32.0	18.6	7824	421
1	9	WI(RICL3A)-45	44	153	112	2614	73.1	35.4	24.7	7378	299
1	9	WI(RICL3A)-46	45	153	112	3502	73.6	34.9	17.8	10021	563

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	10	WI(RICL3A)-47	46	153	107	3912	73.6	37.5	24.9	10430	419
1	10	WI(RICL3A)-48	47	152	109	1759	71.1	30.4	15.6	5790	371
1	10	WI(RICL3A)-49	48	153	114	2523	72.9	32.6	21.2	7729	365
1	10	WI(RICL3A)-50	49	153	109	2190	72.7	30.4	15.4	7206	468
1	10	WI(RICL3A)-51	50	153	104	3310	73.9	34.9	23.9	9497	397
1	11	WI(RICL3A)-52	51	154	109	2042	73.5	31.0	22.5	6591	293
1	11	WI(RICL3A)-53	52	155	109	1615	72.5	31.7	21.6	5099	236
1	11	WI(RICL3A)-54	53	153	107	2483	72.9	33.6	22.8	7399	325
1	11	WI(RICL3A)-55	54	153	109	2567	73.3	33.8	27.6	7593	275
1	11	WI(RICL3A)-56	55	153	112	3448	72.7	31.9	20.6	10794	524
1	12	WI(RICL3A)-57	56	150	109	3051	74.9	33.7	19.5	9042	464
1	12	WI(RICL3A)-58	57	154	109	1389	74.3	30.9	21.3	4504	211
1	12	WI(RICL3A)-59	58	153	109	3118	74.6	37.1	24.0	8399	350
1	12	WI(RICL3A)-60	59	151	107	2183	71.6	32.7	22.4	6681	298
1	12	WI(RICL3A)-61	60	150	107	3626	72.4	33.4	21.0	10863	517
1	13	WI(RICL3A)-62	61	153	102	2173	71.7	34.5	25.2	6302	250
1	13	WI(RICL3A)-63	62	154	104	2321	73.4	30.4	20.7	7626	368
1	13	WI(RICL3A)-64	63	152	102	3145	71.5	30.2	18.7	10428	558
1	13	WI(RICL3A)-65	64	152	102	3091	74.7	35.3	23.3	8763	376
1	13	WI(RICL3A)-66	65	154	104	2032	73.1	32.6	25.9	6228	240
1	14	WI(RICL3A)-67	66	150	99	2910	72.5	33.7	25.9	8642	334
1	14	WI(RICL3A)-68	67	149	104	2842	72.6	33.0	22.1	8617	390
1	14	WI(RICL3A)-69	68	153	114	2449	71.6	32.5	19.6	7535	384
1	14	WI(RICL3A)-70	69	150	112	2715	72.0	35.7	25.1	7613	303
1	14	WI(RICL3A)-71	70	154	102	1349	70.7	30.3	20.7	4453	215
1	15	WI(RICL3A)-72	71	153	112	2637	72.4	32.0	20.9	8239	394
1	15	WI(RICL3A)-73	72	153	112	2671	72.6	29.7	19.8	8994	454
1	15	WI(RICL3A)-74	73	153	107	2506	73.8	32.8	19.3	7641	396
1	15	WI(RICL3A)-75	74	153	109	2240	72.9	35.6	23.2	6292	271
1	15	WI(RICL3A)-76	75	153	104	3307	74.3	34.9	22.4	9484	423
1	16	WI(RICL3A)-77	76	153	114	3505	74.4	34.9	23.3	10045	431
1	16	WI(RICL3A)-78	77	154	97	.	.	30.6	28.5	.	.
1	16	WI(RICL3A)-79	78	151	107	2281	72.0	35.5	24.8	6420	259
1	16	WI(RICL3A)-80	79	150	104	3300	74.4	33.7	24.5	9800	400
1	16	WI(RICL3A)-81	80	150	102	2839	73.6	31.6	21.8	8996	413
1	17	WI(RICL3A)-82	81	152	102	2449	73.9	35.0	24.7	6993	283
1	17	WI(RICL3A)-83	82	151	112	2795	73.3	36.6	26.2	7629	291
1	17	WI(RICL3A)-84	83	154	107	2136	74.2	36.7	25.3	5823	230
1	17	WI(RICL3A)-85	84	153	114	2913	73.1	32.6	21.1	8934	423
1	17	WI(RICL3A)-86	85	150	104	2684	71.1	32.5	21.7	8251	380
1	18	WI(RICL3A)-87	86	153	109	2250	72.6	31.8	22.7	7075	312
1	18	WI(RICL3A)-88	87	154	109	2069	73.0	34.9	27.2	5936	218
1	18	WI(RICL3A)-89	88	151	97	2345	74.2	35.3	21.9	6643	303
1	18	WI(RICL3A)-90	89	150	109	2846	72.0	31.6	21.8	9017	414
1	18	WI(RICL3A)-91	90	154	102	2893	74.0	35.9	23.7	8057	340
1	19	WI(CNN3A)	91	155	118	2173	71.1	32.9	25.9	6598	255
1	19	WI(CNN6A)	92	154	107	1995	72.1	28.4	30.2	7013	232
1	19	WI	93	153	104	2678	74.8	33.9	33.0	7889	239
1	19	CNN	94	157	107	2351	73.4	28.3	32.6	9372	287
1	19	CNN(WI3A)	95	154	104	1470	72.7	30.4	27.9	4836	173

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	20	CNN(WI6A)	96	154	107	2042	72.6	31.6	28.3	6464	228
1	20	Pronghorn	97	153	97	3771	76.1	32.0	29.9	11794	394
1	20	Jagger	98	153	81	3239	77.5	23.1	32.0	14027	438
1	20	Overland	99	155	94	2923	72.9	25.9	29.4	11278	384
1	20	Goodstreak	100	155	107	4817	75.3	28.7	39.2	16785	428
2	19	WI(RICL3A)-1	1	153	109	1901	74.4	34.9	22.7	5440	240
2	5	WI(RICL3A)-2	2	154	107	2412	71.7	25.6	15.6	9406	603
2	11	WI(RICL3A)-3	3	153	104	2923	73.5	35.0	27.6	8361	303
2	6	WI(RICL3A)-4	4	153	104	3310	74.9	34.1	20.8	9697	466
2	4	WI(RICL3A)-5	5	155	112	1201	70.9	29.9	22.7	4021	177
2	12	WI(RICL3A)-6	6	152	114	2742	73.3	34.9	24.7	7856	318
2	9	WI(RICL3A)-7	7	153	104	2261	74.0	37.5	22.4	6028	269
2	16	WI(RICL3A)-8	8	153	109	2479	73.6	33.8	21.2	7340	346
2	5	WI(RICL3A)-9	9	154	112	2210	73.3	36.1	21.4	6126	286
2	13	WI(RICL3A)-10	10	152	102	2496	73.1	34.8	28.2	7182	255
2	15	WI(RICL3A)-11	11	152	107	2429	73.0	35.1	22.6	6913	306
2	7	WI(RICL3A)-12	12	155	104	1547	74.9	32.8	24.7	4724	191
2	20	WI(RICL3A)-13	13	152	112	2654	74.6	31.3	20.0	8479	424
2	1	WI(RICL3A)-14	14	153	114	2250	71.3	30.7	15.7	7330	467
2	8	WI(RICL3A)-15	15	152	97	2261	72.2	33.9	22.1	6670	302
2	14	WI(RICL3A)-16	16	154	109	2590	72.2	34.6	17.8	7485	420
2	6	WI(RICL3A)-17	17	152	109	2762	75.2	34.1	25.5	8104	318
2	9	WI(RICL3A)-18	18	153	112	2664	74.2	38.2	22.2	6966	314
2	3	WI(RICL3A)-19	19	152	104	3337	72.7	32.2	22.3	10378	465
2	17	WI(RICL3A)-20	20	150	99	3445	74.0	35.9	26.2	9601	366
2	12	WI(RICL3A)-21	21	154	104	3455	72.5	38.2	24.4	9035	370
2	17	WI(RICL3A)-22	22	151	104	3014	72.7	34.0	24.9	8871	356
2	1	WI(RICL3A)-23	23	150	97	3051	73.3	31.9	23.9	9557	400
2	18	WI(RICL3A)-25	24	153	114	2358	73.9	37.4	26.6	6304	237
2	5	WI(RICL3A)-26	25	153	114	3128	73.8	34.6	23.9	9052	379
2	13	WI(RICL3A)-27	26	154	112	2089	72.1	32.8	18.1	6376	352
2	16	WI(RICL3A)-28	27	151	102	2223	71.5	30.6	23.7	7259	306
2	4	WI(RICL3A)-29	28	151	102	2546	72.1	33.8	24.4	7540	309
2	19	WI(RICL3A)-30	29	153	112	1934	73.8	34.5	21.8	5600	257
2	20	WI(RICL3A)-31	30	153	107	2789	73.4	29.4	18.2	9487	521
2	16	WI(RICL3A)-32	31	154	104	2590	73.8	34.4	23.3	7528	324
2	5	WI(RICL3A)-33	32	153	109	2614	73.3	35.4	24.0	7380	307
2	2	WI(RICL3A)-34	33	154	112	1601	71.7	27.5	22.9	5820	254
2	13	WI(RICL3A)-35	34	153	112	2560	72.7	35.2	22.4	7277	325
2	17	WI(RICL3A)-36	35	154	109	2254	72.6	31.2	20.4	7229	354
2	7	WI(RICL3A)-37	36	153	104	2217	73.6	35.7	26.4	6213	235
2	11	WI(RICL3A)-38	37	154	112	1702	73.8	32.5	22.0	5245	238
2	8	WI(RICL3A)-39	38	154	104	1897	73.1	37.6	23.3	5040	216
2	4	WI(RICL3A)-40	39	155	112	1954	74.4	30.0	24.9	6506	261
2	15	WI(RICL3A)-41	40	153	109	3670	75.5	38.8	28.1	9461	337
2	11	WI(RICL3A)-42	41	153	109	2355	73.4	31.7	18.8	7440	396
2	3	WI(RICL3A)-43	42	154	109	1864	71.6	31.4	20.2	5938	294
2	14	WI(RICL3A)-44	43	154	109	2402	73.0	33.5	19.4	7168	370
2	15	WI(RICL3A)-45	44	153	109	3075	73.8	35.0	23.6	8774	372
2	3	WI(RICL3A)-46	45	154	107	2163	71.1	33.0	23.9	6560	274

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
2	10	WI(RICL3A)-47	46	154	109	3357	71.2	29.2	20.2	11513	570
2	8	WI(RICL3A)-48	47	153	112	1642	73.6	29.2	22.0	5625	256
2	6	WI(RICL3A)-49	48	153	119	3347	72.9	33.9	22.1	9889	447
2	9	WI(RICL3A)-50	49	153	112	3569	74.0	31.7	20.7	11262	544
2	12	WI(RICL3A)-51	50	153	109	3132	73.3	33.8	21.0	9263	441
2	7	WI(RICL3A)-52	51	154	112	1611	74.0	30.4	25.7	5295	206
2	10	WI(RICL3A)-53	52	156	107	2072	74.7	26.4	18.9	7864	416
2	18	WI(RICL3A)-54	53	153	104	3408	72.4	33.0	21.8	10317	473
2	7	WI(RICL3A)-55	54	154	107	2291	73.8	33.8	22.0	6780	308
2	10	WI(RICL3A)-56	55	153	112	3152	74.3	33.8	23.6	9321	395
2	18	WI(RICL3A)-57	56	150	109	3441	74.2	34.5	24.5	9977	407
2	7	WI(RICL3A)-58	57	153	107	1510	74.6	30.6	21.8	4944	227
2	2	WI(RICL3A)-59	58	154	104	2365	70.7	30.1	17.8	7850	442
2	2	WI(RICL3A)-60	59	151	107	2126	71.1	27.5	17.3	7727	447
2	20	WI(RICL3A)-61	60	151	109	2758	71.7	30.5	19.6	9040	462
2	16	WI(RICL3A)-62	61	154	107	2583	74.0	31.8	21.3	8128	382
2	8	WI(RICL3A)-63	62	154	104	2261	73.9	32.4	23.4	6978	298
2	12	WI(RICL3A)-64	63	151	99	3751	73.9	33.7	23.9	11122	465
2	1	WI(RICL3A)-65	64	151	102	3599	73.3	27.3	24.9	13199	530
2	6	WI(RICL3A)-66	65	151	107	3895	75.3	36.1	25.3	10794	427
2	11	WI(RICL3A)-67	66	151	102	2873	72.5	29.7	20.0	9672	484
2	17	WI(RICL3A)-68	67	150	107	2745	73.8	31.3	19.1	8759	458
2	19	WI(RICL3A)-69	68	153	112	1534	72.5	33.8	20.4	4535	222
2	20	WI(RICL3A)-70	69	150	109	2896	72.4	34.1	22.2	8482	382
2	4	WI(RICL3A)-71	70	154	107	1776	70.8	29.9	21.6	5939	275
2	19	WI(RICL3A)-72	71	153	112	2600	73.1	33.4	23.5	7794	332
2	6	WI(RICL3A)-73	72	151	117	3418	73.6	33.7	24.2	10136	419
2	13	WI(RICL3A)-74	73	153	112	3105	73.5	34.1	16.4	9109	555
2	15	WI(RICL3A)-75	74	153	107	2392	72.6	32.1	24.0	7445	310
2	3	WI(RICL3A)-76	75	154	99	3017	71.5	32.4	20.2	9320	461
2	18	WI(RICL3A)-77	76	153	117	2368	74.0	36.6	25.4	6475	255
2	1	WI(RICL3A)-78	77	153	94	2055	73.1	36.3	26.5	5662	214
2	18	WI(RICL3A)-79	78	150	112	2802	71.8	32.3	20.5	8677	423
2	3	WI(RICL3A)-80	79	151	102	3239	73.3	32.5	27.8	9984	359
2	10	WI(RICL3A)-81	80	151	99	3371	73.6	29.7	23.5	11348	483
2	14	WI(RICL3A)-82	81	150	107	3757	73.6	34.7	21.0	10839	516
2	9	WI(RICL3A)-83	82	150	112	3280	72.5	35.0	24.0	9360	390
2	12	WI(RICL3A)-84	83	153	109	2345	73.4	32.8	20.1	7151	356
2	5	WI(RICL3A)-85	84	153	109	2829	72.7	30.7	18.5	9230	499
2	14	WI(RICL3A)-86	85	151	102	2826	71.5	34.6	25.2	8166	324
2	1	WI(RICL3A)-87	86	153	109	3038	74.0	29.8	22.2	10186	459
2	15	WI(RICL3A)-88	87	153	114	2842	74.7	35.8	23.8	7941	334
2	8	WI(RICL3A)-89	88	152	99	1803	71.2	34.9	24.8	5163	208
2	11	WI(RICL3A)-90	89	151	107	2718	72.1	32.6	20.3	8335	411
2	2	WI(RICL3A)-91	90	154	107	2213	71.6	27.0	21.2	8189	386
2	14	WI(CNN3A)	91	155	119	2375	74.2	35.5	20.3	6696	330
2	2	WI(CNN6A)	92	155	102	2405	73.3	34.1	20.2	7062	350
2	16	WI	93	153	107	2782	74.0	33.2	24.7	8380	339
2	4	CNN	94	157	109	2348	72.4	29.9	21.9	7862	359
2	10	CNN(WI3A)	95	156	109	2038	73.0	30.0	23.9	6804	285

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
2	13	CNN(WI6A)	96	154	109	2365	73.0	37.2	27.8	6358	229
2	17	Pronghorn	97	152	104	4225	77.1	33.0	26.0	12818	493
2	9	Jagger	98	151	86	3646	75.5	23.4	26.7	15577	583
2	19	Overland	99	155	91	3360	73.3	27.7	29.2	12144	416
2	20	Goodstreak	100	154	109	4154	76.5	34.9	29.4	11916	405
3	2	WI(RICL3A)-1	1	153	102	2479	74.0	38.9	24.8	6371	257
3	16	WI(RICL3A)-2	2	153	102	2126	72.0	27.2	18.2	7817	429
3	20	WI(RICL3A)-3	3	154	107	2839	70.7	30.6	20.0	9278	464
3	4	WI(RICL3A)-4	4	153	107	2846	74.2	34.7	19.6	8191	418
3	10	WI(RICL3A)-5	5	154	112	1285	72.2	33.1	18.8	3884	207
3	13	WI(RICL3A)-6	6	152	119	3492	74.2	34.2	23.3	10221	439
3	8	WI(RICL3A)-7	7	153	107	3707	73.4	30.4	20.3	12203	601
3	15	WI(RICL3A)-8	8	153	109	1810	74.2	30.6	20.8	5909	284
3	11	WI(RICL3A)-9	9	153	117	2607	73.5	34.1	22.3	7649	343
3	3	WI(RICL3A)-10	10	152	107	1517	73.5	35.3	29.9	4300	144
3	7	WI(RICL3A)-11	11	153	107	2950	73.1	35.6	26.8	8279	309
3	4	WI(RICL3A)-12	12	153	104	2244	74.6	31.6	21.9	7101	324
3	16	WI(RICL3A)-13	13	153	114	2620	74.3	29.5	18.5	8895	481
3	19	WI(RICL3A)-14	14	154	117	2923	72.6	24.2	20.7	12102	585
3	15	WI(RICL3A)-15	15	150	102	3159	72.2	31.6	23.3	10013	430
3	1	WI(RICL3A)-16	16	153	112	3307	74.0	17.5	25.1	18906	753
3	20	WI(RICL3A)-17	17	155	114	3593	74.7	38.9	24.0	9231	385
3	16	WI(RICL3A)-18	18	154	112	2197	72.7	31.3	20.9	7009	335
3	17	WI(RICL3A)-19	19	153	107	3115	71.7	32.4	22.0	9611	437
3	18	WI(RICL3A)-20	20	151	104	4333	73.3	33.1	19.8	13077	660
3	5	WI(RICL3A)-21	21	153	99	3034	73.9	33.2	21.9	9153	418
3	15	WI(RICL3A)-22	22	150	104	3404	73.3	30.4	18.6	11187	601
3	4	WI(RICL3A)-23	23	150	102	3566	73.6	32.5	22.9	10990	480
3	12	WI(RICL3A)-25	24	153	109	2395	73.8	30.1	17.3	7968	461
3	6	WI(RICL3A)-26	25	154	109	2348	73.9	28.8	24.8	8144	328
3	20	WI(RICL3A)-27	26	155	112	2990	72.9	27.1	22.6	11025	488
3	5	WI(RICL3A)-28	27	151	104	2805	73.5	29.1	20.6	9648	468
3	13	WI(RICL3A)-29	28	150	104	3848	74.3	35.4	25.8	10886	422
3	17	WI(RICL3A)-30	29	153	112	2873	73.8	30.7	23.4	9362	400
3	5	WI(RICL3A)-31	30	153	109	3804	75.7	35.7	24.2	10656	440
3	8	WI(RICL3A)-32	31	153	102	2129	72.1	32.2	26.0	6622	255
3	18	WI(RICL3A)-33	32	153	109	3690	76.0	36.2	22.3	10184	457
3	1	WI(RICL3A)-34	33	153	114	2146	72.5	28.0	15.6	7661	491
3	13	WI(RICL3A)-35	34	154	112	2590	73.6	34.1	24.9	7588	305
3	13	WI(RICL3A)-36	35	153	112	1810	72.1	29.3	17.0	6178	363
3	2	WI(RICL3A)-37	36	155	104	2513	73.5	29.7	21.5	8468	394
3	10	WI(RICL3A)-38	37	154	109	1732	74.3	32.6	25.0	5314	213
3	1	WI(RICL3A)-39	38	152	104	2523	73.4	36.6	22.6	6903	305
3	12	WI(RICL3A)-40	39	154	107	1813	73.0	29.9	20.9	6063	290
3	9	WI(RICL3A)-41	40	152	112	2493	73.9	33.8	27.5	7371	268
3	16	WI(RICL3A)-42	41	153	107	2715	74.2	34.9	25.4	7774	306
3	5	WI(RICL3A)-43	42	153	112	2869	73.8	30.8	24.5	9323	381
3	6	WI(RICL3A)-44	43	154	107	2849	73.6	33.1	25.7	8604	335
3	3	WI(RICL3A)-45	44	153	114	2049	75.3	37.7	23.5	5427	231
3	4	WI(RICL3A)-46	45	153	109	1823	73.4	29.6	15.8	6168	390

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	14	WI(RICL3A)-47	46	152	109	2779	73.3	33.7	22.4	8244	368
3	9	WI(RICL3A)-48	47	152	112	2089	73.9	36.6	23.4	5710	244
3	18	WI(RICL3A)-49	48	154	117	2617	73.3	29.6	21.1	8849	419
3	10	WI(RICL3A)-50	49	153	104	2089	73.8	34.7	21.2	6025	284
3	3	WI(RICL3A)-51	50	153	107	2984	74.3	35.9	26.6	8311	312
3	7	WI(RICL3A)-52	51	153	114	2694	72.4	31.6	24.6	8531	347
3	1	WI(RICL3A)-53	52	155	109	1655	71.2	30.8	19.1	5367	281
3	10	WI(RICL3A)-54	53	154	107	2745	71.5	30.5	18.9	8991	476
3	19	WI(RICL3A)-55	54	155	107	3606	75.3	34.9	23.1	10348	448
3	18	WI(RICL3A)-56	55	154	114	3293	73.4	33.8	21.0	9740	464
3	11	WI(RICL3A)-57	56	150	107	2900	74.7	32.0	19.7	9053	460
3	8	WI(RICL3A)-58	57	153	114	1611	73.5	29.3	24.3	5507	227
3	7	WI(RICL3A)-59	58	153	107	2802	73.9	28.7	17.5	9768	558
3	17	WI(RICL3A)-60	59	151	109	3354	72.7	32.0	19.1	10484	549
3	6	WI(RICL3A)-61	60	150	104	3942	72.7	31.9	21.1	12360	586
3	11	WI(RICL3A)-62	61	152	102	2691	74.4	29.9	17.6	9004	512
3	14	WI(RICL3A)-63	62	152	109	3377	74.0	34.8	25.8	9714	377
3	16	WI(RICL3A)-64	63	150	104	3714	74.2	32.7	23.7	11342	479
3	2	WI(RICL3A)-65	64	153	104	2523	73.8	36.3	23.8	6958	292
3	2	WI(RICL3A)-66	65	153	104	2351	75.6	32.7	23.4	7192	307
3	7	WI(RICL3A)-67	66	150	102	3286	72.4	32.3	24.8	10163	410
3	14	WI(RICL3A)-68	67	150	107	3508	73.9	32.8	25.1	10700	426
3	15	WI(RICL3A)-69	68	153	109	1383	71.1	27.5	20.7	5032	244
3	20	WI(RICL3A)-70	69	152	109	3771	72.5	31.1	24.8	12114	488
3	11	WI(RICL3A)-71	70	153	104	1705	71.5	27.5	18.4	6214	338
3	12	WI(RICL3A)-72	71	153	109	1944	68.7	33.3	22.3	5843	262
3	9	WI(RICL3A)-73	72	152	112	3451	72.5	28.0	15.8	12337	781
3	11	WI(RICL3A)-74	73	154	107	2018	74.4	29.9	18.0	6753	375
3	20	WI(RICL3A)-75	74	154	104	3007	72.5	32.5	21.2	9267	437
3	14	WI(RICL3A)-76	75	153	102	3458	74.8	35.5	23.2	9736	420
3	19	WI(RICL3A)-77	76	154	117	3179	73.9	32.8	21.6	9698	449
3	8	WI(RICL3A)-78	77	153	97	1880	71.3	34.7	26.0	5414	208
3	3	WI(RICL3A)-79	78	151	109	1658	72.6	33.9	21.4	4895	229
3	4	WI(RICL3A)-80	79	150	102	3404	74.7	33.9	20.6	10047	488
3	14	WI(RICL3A)-81	80	150	97	3297	74.3	33.4	23.8	9881	415
3	17	WI(RICL3A)-82	81	150	107	3461	71.7	34.7	23.8	9986	420
3	12	WI(RICL3A)-83	82	150	107	2345	72.5	32.4	19.2	7237	377
3	7	WI(RICL3A)-84	83	153	107	3899	73.9	34.6	19.6	11254	574
3	6	WI(RICL3A)-85	84	153	112	3169	73.9	31.7	21.0	9991	476
3	17	WI(RICL3A)-86	85	151	109	3122	71.6	27.3	18.2	11454	629
3	10	WI(RICL3A)-87	86	153	107	2469	73.6	30.3	18.0	8140	452
3	19	WI(RICL3A)-88	87	155	112	3387	76.1	36.3	23.2	9322	402
3	12	WI(RICL3A)-89	88	150	102	2802	73.5	31.0	20.2	9027	447
3	18	WI(RICL3A)-90	89	152	109	2853	71.8	29.4	21.3	9690	455
3	3	WI(RICL3A)-91	90	153	107	2119	73.4	33.0	19.4	6424	331
3	13	WI(CNN3A)	91	154	117	2193	73.4	34.2	23.0	6418	279
3	2	WI(CNN6A)	92	154	109	2217	72.5	34.8	21.4	6368	298
3	9	WI	93	152	109	2826	74.4	30.9	22.2	9157	413
3	6	CNN	94	158	109	2235	75.6	28.2	28.5	10171	357
3	19	CNN(WI3A)	95	157	109	1988	69.3	23.4	21.9	8503	388

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	1	CNN(WI6A)	96	154	104	2543	72.5	30.4	21.0	8371	399
3	8	Pronghorn	97	153	102	3475	73.9	34.3	28.3	10127	358
3	15	Jagger	98	151	79	3858	76.2	24.5	20.8	15736	757
3	5	Overland	99	154	94	3801	76.5	30.6	27.9	12418	445
3	9	Goodstreak	100	154	112	3653	73.6	29.5	28.1	12383	441

Appendix 7. Field dataset for anthesis date (AD), plant height (PHT), grain yield (GYLD), grain volume weight (GVW), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), and spikes per square meter (SPSM), evaluated in WI(RICLs-3A) mapping population at North Platte, NE during 2008 cropping season.

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	1	WI(RICL3A)-1	1	153	122	4856	78.3	38.7	24.2	12541	518
1	1	WI(RICL3A)-2	2	153	124	5155	77.7	37.1	24.5	13909	568
1	1	WI(RICL3A)-3	3	153	122	5113	78.0	40.1	21.5	12738	592
1	1	WI(RICL3A)-4	4	153	117	4261	77.5	41.4	24.0	10288	429
1	1	WI(RICL3A)-5	5	154	124	4572	77.3	40.5	23.8	11287	474
1	2	WI(RICL3A)-6	6	154	122	5086	77.4	38.0	21.2	13394	632
1	2	WI(RICL3A)-7	7	154	127	4958	78.2	41.4	19.2	11973	624
1	2	WI(RICL3A)-8	8	155	117	3950	76.6	39.2	25.8	10090	391
1	2	WI(RICL3A)-9	9	155	122	4593	77.1	38.5	26.4	11934	452
1	2	WI(RICL3A)-10	10	154	117	4327	78.2	37.0	22.2	11699	527
1	3	WI(RICL3A)-11	11	153	119	4087	77.9	39.1	22.6	10462	463
1	3	WI(RICL3A)-12	12	153	119	4276	77.8	41.4	21.5	10318	480
1	3	WI(RICL3A)-13	13	153	117	3917	77.4	39.3	25.1	9971	397
1	3	WI(RICL3A)-14	14	155	119	3172	75.1	37.5	24.2	8465	350
1	3	WI(RICL3A)-15	15	153	114	4345	75.5	39.1	24.4	11124	456
1	4	WI(RICL3A)-16	16	155	124	4835	77.1	42.1	26.7	11495	431
1	4	WI(RICL3A)-17	17	154	119	4593	75.3	39.8	22.3	11534	517
1	4	WI(RICL3A)-18	18	155	124	5116	75.2	38.8	26.2	13193	504
1	4	WI(RICL3A)-19	19	153	112	4144	75.1	38.9	22.5	10657	474
1	4	WI(RICL3A)-20	20	153	109	4653	77.1	38.3	21.5	12140	565
1	5	WI(RICL3A)-21	21	155	122	4886	75.2	40.0	23.1	12214	529
1	5	WI(RICL3A)-22	22	153	114	4808	76.6	38.9	25.0	12366	495
1	5	WI(RICL3A)-23	23	153	117	4491	77.9	41.2	24.5	10905	445
1	5	WI(RICL3A)-25	24	153	117	4709	77.7	40.7	23.0	11572	503
1	5	WI(RICL3A)-26	25	155	124	4781	77.0	38.1	22.1	12549	568
1	6	WI(RICL3A)-27	26	155	119	4937	76.7	36.9	20.1	13373	665
1	6	WI(RICL3A)-28	27	154	117	4404	77.0	39.1	23.5	11263	479
1	6	WI(RICL3A)-29	28	153	119	4500	76.6	38.5	24.2	11685	483
1	6	WI(RICL3A)-30	29	154	117	4563	75.8	36.7	25.1	12424	495
1	6	WI(RICL3A)-31	30	154	114	4201	76.4	36.7	19.6	11436	583
1	7	WI(RICL3A)-32	31	155	119	4380	76.2	39.6	25.0	11062	442
1	7	WI(RICL3A)-33	32	155	124	4763	77.5	39.6	22.1	12017	544
1	7	WI(RICL3A)-34	33	155	119	4207	76.4	39.3	22.2	10698	482
1	7	WI(RICL3A)-35	34	155	117	4001	76.6	35.7	23.5	11206	477
1	7	WI(RICL3A)-36	35	155	124	3681	74.8	37.6	23.4	9788	418
1	8	WI(RICL3A)-37	36	155	122	4455	74.0	36.5	22.6	12219	541
1	8	WI(RICL3A)-38	37	155	122	3788	75.2	38.5	24.4	9844	403
1	8	WI(RICL3A)-39	38	153	117	3869	75.5	38.9	18.8	9937	529
1	8	WI(RICL3A)-40	39	155	114	3660	74.2	34.5	24.1	10617	440
1	8	WI(RICL3A)-41	40	154	122	4162	76.4	40.0	24.2	10405	430
1	9	WI(RICL3A)-42	41	154	122	4377	75.3	35.0	21.2	12507	590
1	9	WI(RICL3A)-43	42	154	117	3806	75.7	37.8	24.7	10066	408
1	9	WI(RICL3A)-44	43	155	117	3854	75.3	36.8	23.6	10467	444
1	9	WI(RICL3A)-45	44	154	119	3947	76.1	36.7	22.7	10756	474

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	9	WI(RICL3A)-46	45	155	119	4150	76.5	39.8	23.3	10420	447
1	10	WI(RICL3A)-47	46	153	114	4022	76.7	39.3	20.9	10238	490
1	10	WI(RICL3A)-48	47	153	119	4108	75.8	36.6	24.4	11213	460
1	10	WI(RICL3A)-49	48	154	119	4150	75.5	38.4	24.1	10801	448
1	10	WI(RICL3A)-50	49	154	109	3367	75.3	37.0	21.5	9094	423
1	10	WI(RICL3A)-51	50	153	119	4377	74.8	38.9	23.9	11262	471
1	11	WI(RICL3A)-52	51	154	122	4665	76.0	39.2	23.3	11904	511
1	11	WI(RICL3A)-53	52	155	122	3747	76.2	36.7	22.1	10222	463
1	11	WI(RICL3A)-54	53	155	119	4096	72.0	36.7	21.9	11172	510
1	11	WI(RICL3A)-55	54	154	114	4452	73.1	36.8	23.4	12114	518
1	11	WI(RICL3A)-56	55	153	119	4715	74.7	37.7	22.0	12499	568
1	12	WI(RICL3A)-57	56	152	112	4440	73.6	39.4	19.6	11273	575
1	12	WI(RICL3A)-58	57	155	117	3549	72.9	36.2	27.0	9798	363
1	12	WI(RICL3A)-59	58	153	117	4488	77.1	39.3	22.2	11413	514
1	12	WI(RICL3A)-60	59	152	109	4058	75.6	37.2	21.1	10906	517
1	12	WI(RICL3A)-61	60	153	117	3280	75.7	38.4	19.7	8536	433
1	13	WI(RICL3A)-62	61	153	117	4096	77.4	38.7	26.2	10595	404
1	13	WI(RICL3A)-63	62	153	109	4691	77.7	38.5	22.2	12196	549
1	13	WI(RICL3A)-64	63	152	107	4324	77.7	39.1	21.9	11049	505
1	13	WI(RICL3A)-65	64	154	114	4518	76.6	39.0	20.0	11585	579
1	13	WI(RICL3A)-66	65	154	114	4351	77.0	38.8	22.0	11208	509
1	14	WI(RICL3A)-67	66	152	107	4201	77.7	36.9	23.8	11388	478
1	14	WI(RICL3A)-68	67	152	112	4446	77.4	38.5	23.2	11564	498
1	14	WI(RICL3A)-69	68	155	119	4700	76.0	36.6	21.5	12841	597
1	14	WI(RICL3A)-70	69	153	117	4294	76.5	38.0	21.5	11299	526
1	14	WI(RICL3A)-71	70	155	119	3630	76.4	37.6	29.6	9645	326
1	15	WI(RICL3A)-72	71	154	119	4949	77.7	38.8	25.1	12766	509
1	15	WI(RICL3A)-73	72	155	122	4987	78.2	39.1	24.2	12759	527
1	15	WI(RICL3A)-74	73	155	122	4662	77.5	41.1	23.8	11332	476
1	15	WI(RICL3A)-75	74	153	119	4754	77.5	40.0	22.9	11899	520
1	15	WI(RICL3A)-76	75	153	117	4886	77.7	39.4	21.9	12413	567
1	16	WI(RICL3A)-77	76	153	117	4518	77.7	38.8	19.3	11657	604
1	16	WI(RICL3A)-78	77	155	109	2703	72.6	32.0	18.3	8456	462
1	16	WI(RICL3A)-79	78	153	114	3513	75.6	38.4	21.8	9140	419
1	16	WI(RICL3A)-80	79	153	117	4793	78.6	42.0	24.6	11414	464
1	16	WI(RICL3A)-81	80	153	119	4058	77.5	38.4	20.2	10576	524
1	17	WI(RICL3A)-82	81	153	112	4309	80.9	40.8	21.0	10558	503
1	17	WI(RICL3A)-83	82	153	117	4213	76.7	38.2	20.5	11044	539
1	17	WI(RICL3A)-84	83	154	112	4392	77.7	39.7	19.1	11053	579
1	17	WI(RICL3A)-85	84	154	114	3486	73.3	38.7	23.1	9019	390
1	17	WI(RICL3A)-86	85	153	119	4264	74.3	36.3	23.6	11742	498
1	18	WI(RICL3A)-87	86	155	122	4159	71.2	36.7	25.1	11323	451
1	18	WI(RICL3A)-88	87	155	117	4467	72.6	36.8	23.7	12141	512
1	18	WI(RICL3A)-89	88	153	119	3839	74.0	37.7	20.5	10182	497
1	18	WI(RICL3A)-90	89	153	117	3809	74.7	39.9	21.8	9556	438
1	18	WI(RICL3A)-91	90	154	114	3779	75.3	38.5	19.7	9823	499
1	19	WI(CNN3A)	91	156	122	4488	75.3	35.7	20.3	12567	619
1	19	WI(CNN6A)	92	155	117	3788	76.4	40.6	22.1	9323	422

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	19	WI	93	154	119	4527	76.4	36.5	20.1	12397	617
1	19	CNN	94	158	122	4133	77.9	31.5	24.0	14371	599
1	19	CNN(WI3A)	95	157	119	4790	77.3	33.4	23.7	14334	605
1	20	CNN(WI6A)	96	155	114	4168	75.3	36.6	19.0	11395	600
1	20	Pronghorn	97	155	117	6172	77.9	37.4	23.1	16500	714
1	20	Jagger	98	152	97	6602	77.0	32.1	29.9	20584	688
1	20	Overland	99	155	99	6252	77.0	35.5	30.0	17595	587
1	20	Goodstreak	100	156	117	6013	76.9	33.7	30.1	17832	592
2	10	WI(RICL3A)-1	1	154	117	4778	74.9	40.2	23.8	11883	499
2	20	WI(RICL3A)-2	2	155	114	4569	76.6	37.1	24.8	12303	496
2	15	WI(RICL3A)-3	3	153	112	4449	76.1	38.2	18.8	11634	619
2	8	WI(RICL3A)-4	4	153	117	4703	77.7	40.9	24.1	11496	477
2	19	WI(RICL3A)-5	5	155	119	4775	75.8	40.3	21.8	11856	544
2	3	WI(RICL3A)-6	6	155	117	4928	74.2	40.8	21.2	12091	570
2	6	WI(RICL3A)-7	7	154	122	4709	75.2	40.0	20.5	11773	574
2	6	WI(RICL3A)-8	8	155	122	4497	75.8	39.6	22.7	11368	501
2	20	WI(RICL3A)-9	9	155	119	4407	76.7	38.6	21.5	11417	531
2	2	WI(RICL3A)-10	10	154	112	4545	75.7	36.6	24.7	12404	502
2	14	WI(RICL3A)-11	11	154	112	3651	75.3	39.0	20.4	9368	459
2	11	WI(RICL3A)-12	12	153	117	5044	76.0	41.2	22.1	12250	554
2	8	WI(RICL3A)-13	13	153	119	4766	79.1	38.4	20.5	12415	606
2	14	WI(RICL3A)-14	14	155	122	3875	75.8	37.0	22.5	10467	465
2	13	WI(RICL3A)-15	15	153	114	4022	76.0	34.9	19.5	11533	591
2	16	WI(RICL3A)-16	16	155	122	4219	74.8	37.2	21.1	11355	538
2	7	WI(RICL3A)-17	17	153	117	4398	75.8	40.0	21.5	10996	511
2	11	WI(RICL3A)-18	18	155	122	4404	77.0	39.9	23.9	11049	463
2	7	WI(RICL3A)-19	19	155	117	4300	76.6	38.8	24.8	11085	447
2	2	WI(RICL3A)-20	20	153	114	3842	75.1	38.3	21.5	10037	467
2	1	WI(RICL3A)-21	21	155	119	4566	75.7	41.1	18.9	11120	588
2	12	WI(RICL3A)-22	22	153	122	4123	76.9	38.5	22.1	10708	485
2	16	WI(RICL3A)-23	23	153	117	3830	77.1	38.5	23.8	9952	418
2	4	WI(RICL3A)-25	24	153	114	3454	73.8	39.2	20.6	8805	427
2	15	WI(RICL3A)-26	25	155	122	3920	75.8	33.7	17.8	11629	653
2	12	WI(RICL3A)-27	26	155	114	4001	76.6	38.9	22.5	10288	457
2	10	WI(RICL3A)-28	27	154	119	4736	74.4	37.8	20.2	12523	620
2	2	WI(RICL3A)-29	28	154	122	4467	76.0	39.7	21.4	11260	526
2	10	WI(RICL3A)-30	29	154	114	3636	73.9	38.9	25.2	9359	371
2	16	WI(RICL3A)-31	30	154	117	3959	76.2	37.7	21.2	10504	495
2	5	WI(RICL3A)-32	31	155	117	4312	75.7	40.6	22.7	10627	468
2	1	WI(RICL3A)-33	32	154	117	4386	76.9	41.8	24.1	10487	435
2	13	WI(RICL3A)-34	33	155	122	4261	76.4	36.7	25.7	11600	451
2	14	WI(RICL3A)-35	34	155	119	3708	73.1	37.7	20.8	9837	473
2	10	WI(RICL3A)-36	35	155	122	4572	73.3	38.5	23.2	11864	511
2	1	WI(RICL3A)-37	36	155	117	4512	73.1	38.4	21.6	11742	544
2	8	WI(RICL3A)-38	37	155	124	4563	76.9	38.7	21.6	11789	546
2	12	WI(RICL3A)-39	38	153	117	4383	77.3	38.7	20.0	11341	567
2	5	WI(RICL3A)-40	39	155	114	3639	76.2	35.4	21.5	10267	478
2	18	WI(RICL3A)-41	40	153	114	4303	77.3	37.4	22.1	11498	520

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
2	13	WI(RICL3A)-42	41	155	112	3899	76.4	34.5	19.0	11293	594
2	4	WI(RICL3A)-43	42	155	119	4551	70.7	39.3	23.3	11589	497
2	5	WI(RICL3A)-44	43	155	117	3612	75.1	37.8	23.5	9548	406
2	9	WI(RICL3A)-45	44	153	114	4464	76.6	39.0	19.2	11444	596
2	20	WI(RICL3A)-46	45	155	124	4428	76.4	39.5	22.9	11205	489
2	2	WI(RICL3A)-47	46	154	119	4470	75.2	38.7	20.9	11563	553
2	12	WI(RICL3A)-48	47	154	117	4392	76.1	39.4	21.4	11150	521
2	18	WI(RICL3A)-49	48	155	117	4443	75.6	38.7	21.8	11477	526
2	17	WI(RICL3A)-50	49	155	112	4025	73.9	34.1	22.6	11813	523
2	11	WI(RICL3A)-51	50	153	114	4841	77.4	38.8	24.9	12465	501
2	16	WI(RICL3A)-52	51	155	117	4509	74.6	38.8	24.1	11622	482
2	1	WI(RICL3A)-53	52	156	122	4013	76.5	37.2	25.6	10790	422
2	9	WI(RICL3A)-54	53	155	117	4497	76.2	36.4	21.4	12354	577
2	14	WI(RICL3A)-55	54	155	114	3938	75.7	37.9	23.2	10382	447
2	13	WI(RICL3A)-56	55	155	117	4135	76.5	38.8	19.9	10660	536
2	17	WI(RICL3A)-57	56	152	107	4052	73.0	40.0	25.1	10139	404
2	19	WI(RICL3A)-58	57	156	122	3824	75.8	33.4	24.6	11445	465
2	9	WI(RICL3A)-59	58	154	117	4662	85.8	40.1	20.8	11640	560
2	17	WI(RICL3A)-60	59	153	112	3618	74.3	40.5	23.7	8932	377
2	7	WI(RICL3A)-61	60	153	117	4482	76.2	36.0	20.4	12457	611
2	3	WI(RICL3A)-62	61	154	114	4162	74.9	40.0	22.4	10405	465
2	8	WI(RICL3A)-63	62	155	119	5280	77.0	44.2	22.6	11958	529
2	5	WI(RICL3A)-64	63	153	114	4081	76.6	39.8	22.9	10260	448
2	15	WI(RICL3A)-65	64	153	119	4641	76.2	38.5	20.4	12044	590
2	16	WI(RICL3A)-66	65	155	117	3977	76.4	38.4	23.2	10366	447
2	19	WI(RICL3A)-67	66	152	112	4369	77.3	36.6	24.7	11949	484
2	8	WI(RICL3A)-68	67	152	117	4835	77.1	36.4	23.5	13274	565
2	3	WI(RICL3A)-69	68	155	114	4288	74.8	38.8	18.7	11044	591
2	19	WI(RICL3A)-70	69	153	117	3699	74.6	38.4	20.5	9635	470
2	6	WI(RICL3A)-71	70	155	117	4730	78.4	36.5	21.3	12951	608
2	1	WI(RICL3A)-72	71	155	117	4377	74.6	37.9	19.8	11541	583
2	13	WI(RICL3A)-73	72	155	122	4557	76.5	37.3	17.3	12203	705
2	4	WI(RICL3A)-74	73	154	117	4536	74.9	40.7	22.4	11153	498
2	17	WI(RICL3A)-75	74	155	112	4632	74.8	39.9	21.6	11619	538
2	11	WI(RICL3A)-76	75	153	119	4697	76.2	39.3	23.0	11951	520
2	15	WI(RICL3A)-77	76	155	114	3702	75.5	39.1	21.3	9477	445
2	6	WI(RICL3A)-78	77	155	112	2419	67.3	38.5	25.0	6286	251
2	3	WI(RICL3A)-79	78	153	119	3926	74.3	40.9	23.1	9607	416
2	20	WI(RICL3A)-80	79	153	117	4171	76.5	40.5	22.3	10301	462
2	19	WI(RICL3A)-81	80	153	112	4841	77.4	38.8	23.4	12489	534
2	7	WI(RICL3A)-82	81	153	112	5047	76.6	40.9	19.7	12352	627
2	9	WI(RICL3A)-83	82	153	119	4542	76.5	39.7	18.2	11433	628
2	4	WI(RICL3A)-84	83	153	114	4641	74.4	40.5	21.6	11469	531
2	18	WI(RICL3A)-85	84	155	109	3343	71.7	38.9	20.3	8590	423
2	10	WI(RICL3A)-86	85	153	114	4491	74.2	38.0	22.3	11810	530
2	7	WI(RICL3A)-87	86	155	119	4458	75.2	36.8	23.1	12130	525
2	14	WI(RICL3A)-88	87	155	117	4814	75.6	37.3	23.6	12896	546
2	15	WI(RICL3A)-89	88	152	112	4446	76.5	36.5	19.5	12177	624

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
2	3	WI(RICL3A)-90	89	153	114	4608	73.5	39.4	24.3	11688	481
2	11	WI(RICL3A)-91	90	153	112	4431	76.6	38.8	20.2	11432	566
2	17	WI(CNN3A)	91	156	121	4007	72.1	38.5	25.9	10398	401
2	18	WI(CNN6A)	92	155	119	3262	73.8	40.8	20.2	7997	396
2	2	WI	93	153	117	4883	76.0	40.6	24.0	12019	501
2	6	CNN	94	158	122	4235	77.0	32.6	20.8	14197	683
2	4	CNN(WI3A)	95	156	112	5266	75.8	33.9	22.8	15531	681
2	12	CNN(WI6A)	96	155	117	4222	77.4	40.4	22.2	10449	471
2	20	Pronghorn	97	155	109	6811	79.5	39.5	28.3	17257	610
2	5	Jagger	98	153	89	5481	75.6	36.1	27.7	15164	548
2	18	Overland	99	155	94	5155	75.5	34.5	24.8	14952	603
2	9	Goodstreak	100	156	117	6817	79.6	34.2	23.3	19955	856
3	4	WI(RICL3A)-1	1	154	114	4560	75.3	38.6	21.6	11824	547
3	5	WI(RICL3A)-2	2	155	119	4078	75.7	39.4	22.9	10354	452
3	3	WI(RICL3A)-3	3	154	117	4207	77.3	41.8	21.9	10069	460
3	20	WI(RICL3A)-4	4	155	117	4267	76.5	38.5	22.3	11090	497
3	13	WI(RICL3A)-5	5	155	122	4437	76.7	39.7	27.6	11184	405
3	14	WI(RICL3A)-6	6	153	117	4560	76.9	39.7	25.7	11478	447
3	12	WI(RICL3A)-7	7	154	117	4832	77.1	40.3	24.1	11980	497
3	2	WI(RICL3A)-8	8	155	124	4530	76.7	38.3	24.2	11826	489
3	17	WI(RICL3A)-9	9	155	119	5155	74.9	39.0	22.6	13224	585
3	6	WI(RICL3A)-10	10	153	112	4647	75.7	37.2	19.2	12495	651
3	12	WI(RICL3A)-11	11	155	114	4108	75.2	39.0	23.4	10530	450
3	2	WI(RICL3A)-12	12	154	119	4814	75.6	39.0	22.4	12338	551
3	10	WI(RICL3A)-13	13	153	117	3977	74.0	38.9	22.5	10226	454
3	5	WI(RICL3A)-14	14	155	117	3702	74.8	40.2	19.5	9219	473
3	16	WI(RICL3A)-15	15	153	114	4174	76.9	39.8	25.6	10497	410
3	14	WI(RICL3A)-16	16	155	119	4566	76.1	40.3	26.4	11329	429
3	10	WI(RICL3A)-17	17	154	119	3980	75.2	39.2	20.8	10145	488
3	8	WI(RICL3A)-18	18	155	122	4351	74.8	41.2	25.3	10573	418
3	14	WI(RICL3A)-19	19	155	112	3794	76.2	40.4	27.5	9401	342
3	11	WI(RICL3A)-20	20	154	117	3779	73.3	40.2	23.6	9409	399
3	17	WI(RICL3A)-21	21	155	119	4629	75.8	41.3	25.3	11217	443
3	15	WI(RICL3A)-22	22	153	124	4189	77.3	37.8	23.7	11093	468
3	7	WI(RICL3A)-23	23	153	117	4300	75.1	37.5	20.6	11459	556
3	11	WI(RICL3A)-25	24	155	114	3591	76.4	40.1	27.6	8961	325
3	19	WI(RICL3A)-26	25	155	119	3944	76.0	40.0	25.2	9850	391
3	2	WI(RICL3A)-27	26	155	119	4219	76.0	37.4	23.1	11293	489
3	16	WI(RICL3A)-28	27	153	119	4243	74.4	37.6	23.3	11285	484
3	19	WI(RICL3A)-29	28	153	117	4285	76.1	40.6	23.5	10555	449
3	19	WI(RICL3A)-30	29	154	119	4539	76.9	38.1	23.6	11902	504
3	11	WI(RICL3A)-31	30	153	112	4210	74.6	38.9	23.5	10824	461
3	4	WI(RICL3A)-32	31	155	114	4476	74.6	39.9	24.9	11213	450
3	15	WI(RICL3A)-33	32	153	117	4455	77.7	41.3	23.3	10791	463
3	3	WI(RICL3A)-34	33	155	122	4348	73.5	39.5	24.5	11004	449
3	8	WI(RICL3A)-35	34	155	122	4201	75.5	37.7	25.5	11136	437
3	6	WI(RICL3A)-36	35	155	119	4479	74.0	37.3	18.3	12001	656
3	7	WI(RICL3A)-37	36	155	119	3851	73.8	37.7	21.1	10209	484

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	10	WI(RICL3A)-38	37	155	114	4712	73.8	41.8	25.9	11280	436
3	3	WI(RICL3A)-39	38	155	122	4449	73.6	39.4	21.4	11295	528
3	15	WI(RICL3A)-40	39	155	109	3310	76.0	37.0	23.5	8951	381
3	10	WI(RICL3A)-41	40	154	117	4524	77.3	38.2	21.3	11838	556
3	20	WI(RICL3A)-42	41	155	114	5014	77.0	42.5	24.7	11796	478
3	12	WI(RICL3A)-43	42	155	119	4446	75.8	37.5	25.1	11847	472
3	1	WI(RICL3A)-44	43	155	124	4874	76.0	38.3	22.2	12714	573
3	2	WI(RICL3A)-45	44	155	117	3908	76.1	38.8	21.5	10075	469
3	19	WI(RICL3A)-46	45	156	124	3687	76.6	39.8	26.0	9270	357
3	4	WI(RICL3A)-47	46	153	117	4348	75.2	40.7	18.8	10670	568
3	8	WI(RICL3A)-48	47	155	117	4360	76.0	39.1	24.4	11150	457
3	18	WI(RICL3A)-49	48	155	124	4647	75.8	37.4	22.9	12416	542
3	12	WI(RICL3A)-50	49	153	109	3989	75.7	38.6	26.0	10340	398
3	5	WI(RICL3A)-51	50	154	112	4126	75.7	38.9	20.8	10609	510
3	7	WI(RICL3A)-52	51	155	112	4129	76.4	37.7	24.3	10954	451
3	1	WI(RICL3A)-53	52	155	127	4037	77.7	37.8	23.5	10670	454
3	17	WI(RICL3A)-54	53	155	122	4554	74.8	38.2	26.3	11917	453
3	12	WI(RICL3A)-55	54	155	112	3732	76.2	39.6	26.6	9435	355
3	9	WI(RICL3A)-56	55	154	117	4473	76.5	37.2	21.0	12012	572
3	6	WI(RICL3A)-57	56	152	117	4584	75.8	41.1	22.4	11161	498
3	6	WI(RICL3A)-58	57	155	119	3836	75.7	36.0	23.9	10649	446
3	20	WI(RICL3A)-59	58	155	114	3884	76.0	38.5	24.0	10078	420
3	16	WI(RICL3A)-60	59	153	109	3770	75.5	41.4	25.4	9112	359
3	8	WI(RICL3A)-61	60	153	122	4046	74.7	37.0	24.0	10946	456
3	6	WI(RICL3A)-62	61	153	112	3842	74.2	38.1	20.5	10085	492
3	1	WI(RICL3A)-63	62	155	119	4925	76.7	38.2	20.9	12882	616
3	13	WI(RICL3A)-64	63	152	114	4363	76.7	40.5	20.4	10761	528
3	15	WI(RICL3A)-65	64	153	117	4560	77.8	40.3	24.0	11317	472
3	1	WI(RICL3A)-66	65	153	119	4766	77.1	40.0	23.2	11903	513
3	16	WI(RICL3A)-67	66	152	114	4509	77.5	37.1	20.7	12169	588
3	18	WI(RICL3A)-68	67	153	114	3902	76.6	35.4	20.2	11039	547
3	4	WI(RICL3A)-69	68	155	117	4120	74.2	39.0	23.3	10561	453
3	5	WI(RICL3A)-70	69	153	114	4138	74.4	36.4	17.6	11362	646
3	17	WI(RICL3A)-71	70	156	122	4467	73.3	36.7	25.0	12168	487
3	20	WI(RICL3A)-72	71	155	117	4769	76.5	40.4	25.4	11818	465
3	18	WI(RICL3A)-73	72	155	119	4859	74.4	35.1	22.2	13847	624
3	7	WI(RICL3A)-74	73	155	109	4617	75.8	39.3	24.5	11745	479
3	11	WI(RICL3A)-75	74	153	119	4351	75.1	38.6	23.8	11279	474
3	13	WI(RICL3A)-76	75	155	119	5137	77.3	37.8	20.8	13577	653
3	9	WI(RICL3A)-77	76	154	114	4072	75.5	37.0	19.7	11020	559
3	18	WI(RICL3A)-78	77	155	114	2015	71.5	32.6	20.4	6192	304
3	13	WI(RICL3A)-79	78	153	112	4252	75.7	39.8	24.4	10684	438
3	8	WI(RICL3A)-80	79	153	114	4500	75.3	40.7	20.8	11064	532
3	17	WI(RICL3A)-81	80	153	117	4536	74.9	38.8	23.2	11693	504
3	9	WI(RICL3A)-82	81	152	109	3995	76.0	38.9	18.4	10266	558
3	16	WI(RICL3A)-83	82	153	122	4491	76.7	38.9	21.6	11535	534
3	3	WI(RICL3A)-84	83	155	112	4096	74.7	40.9	26.2	10012	382
3	4	WI(RICL3A)-85	84	154	112	3591	74.4	38.4	23.7	9363	395

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	18	WI(RICL3A)-86	85	153	119	4333	78.4	38.4	22.6	11294	500
3	11	WI(RICL3A)-87	86	155	117	3391	73.4	32.3	21.7	10511	484
3	15	WI(RICL3A)-88	87	154	114	4446	76.6	37.6	23.4	11823	505
3	9	WI(RICL3A)-89	88	152	114	4022	75.7	38.9	22.2	10333	465
3	5	WI(RICL3A)-90	89	153	112	3618	73.5	40.4	19.5	8953	459
3	10	WI(RICL3A)-91	90	155	114	3750	73.5	40.3	23.4	9304	398
3	2	WI(CNN3A)	91	155	124	4533	76.4	40.8	24.8	11108	448
3	14	WI(CNN6A)	92	156	117	3995	76.4	40.6	23.7	9842	415
3	20	WI	93	154	119	5071	77.4	38.3	21.9	13237	604
3	3	CNN	94	158	120	3995	74.9	31.3	21.2	12774	603
3	19	CNN(WI3A)	95	157	114	4443	80.0	36.1	23.3	12295	528
3	1	CNN(WI6A)	96	155	117	4566	77.7	38.5	18.8	11856	631
3	7	Pronghorn	97	155	114	5926	78.7	39.1	26.2	15163	579
3	9	Jagger	98	152	91	5875	76.9	34.3	33.0	17128	519
3	14	Overland	99	155	99	4808	77.3	34.6	30.9	13885	449
3	13	Goodstreak	100	156	119	6252	79.6	36.0	29.7	17371	585

Appendix 8. Field dataset for anthesis date (AD), plant height (PHT), grain yield (GYLD), grain volume weight (GVW), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), and spikes per square meter (SPSM), evaluated in WI(RICLs-3A) mapping population at Lincoln, NE during 2009 cropping season.

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	1	WI(RICL3A)-1	1	145	89	3640	81.7	40.2	37.5	9057	242
1	1	WI(RICL3A)-2	2	144	89	3290	80.8	38.5	39.0	8542	219
1	1	WI(RICL3A)-3	3	143	86	3320	81.4	40.1	37.4	8278	221
1	1	WI(RICL3A)-4	4	142	86	4158	81.8	40.9	39.0	10166	261
1	1	WI(RICL3A)-5	5	142	94	3344	80.2	38.6	33.4	8664	259
1	2	WI(RICL3A)-6	6	143	89	4144	80.9	39.9	39.8	10386	261
1	2	WI(RICL3A)-7	7	143	91	3969	81.5	38.0	33.1	10452	316
1	2	WI(RICL3A)-8	8	144	91	3347	81.4	37.0	32.8	9035	275
1	2	WI(RICL3A)-9	9	143	84	3105	80.2	38.3	36.3	8108	223
1	2	WI(RICL3A)-10	10	143	91	4346	81.5	36.6	42.8	11878	278
1	3	WI(RICL3A)-11	11	144	86	3475	81.3	39.5	35.2	8799	250
1	3	WI(RICL3A)-12	12	145	81	3599	81.9	38.5	33.2	9357	282
1	3	WI(RICL3A)-13	13	144	94	3717	82.0	39.7	38.7	9353	242
1	3	WI(RICL3A)-14	14	143	84	3058	80.1	40.8	40.8	7497	184
1	3	WI(RICL3A)-15	15	143	89	3915	81.0	39.3	37.2	9963	268
1	4	WI(RICL3A)-16	16	145	84	3535	81.9	37.8	30.1	9343	310
1	4	WI(RICL3A)-17	17	145	89	3559	81.7	38.1	34.9	9332	267
1	4	WI(RICL3A)-18	18	146	97	3424	81.5	38.4	34.9	8925	256
1	4	WI(RICL3A)-19	19	145	81	3529	81.7	37.9	32.0	9309	291
1	4	WI(RICL3A)-20	20	142	94	3690	82.0	38.2	34.3	9662	282
1	5	WI(RICL3A)-21	21	145	84	3656	81.9	40.8	41.5	8952	216
1	5	WI(RICL3A)-22	22	143	81	3078	80.6	38.6	35.8	7973	223
1	5	WI(RICL3A)-23	23	143	84	3132	80.4	37.6	34.7	8327	240
1	5	WI(RICL3A)-25	24	145	86	3418	81.7	38.3	37.4	8932	239
1	5	WI(RICL3A)-26	25	145	94	3350	80.5	40.5	38.9	8269	213
1	6	WI(RICL3A)-27	26	145	91	3821	81.0	37.8	34.4	10119	294
1	6	WI(RICL3A)-28	27	142	86	3899	80.9	38.7	35.6	10064	283
1	6	WI(RICL3A)-29	28	143	94	3801	81.0	40.3	35.9	9430	263
1	6	WI(RICL3A)-30	29	144	89	3841	82.2	40.5	35.3	9483	269
1	6	WI(RICL3A)-31	30	144	81	3364	81.8	38.8	32.7	8681	265
1	7	WI(RICL3A)-32	31	145	89	4272	81.9	39.2	37.6	10890	290
1	7	WI(RICL3A)-33	32	144	89	4134	82.7	40.7	32.7	10164	311
1	7	WI(RICL3A)-34	33	145	97	3771	81.3	37.6	30.7	10040	327
1	7	WI(RICL3A)-35	34	143	97	3973	81.3	37.2	34.7	10669	307
1	7	WI(RICL3A)-36	35	143	94	4269	81.0	39.6	33.2	10777	325
1	8	WI(RICL3A)-37	36	143	94	3882	81.3	37.2	34.2	10445	305
1	8	WI(RICL3A)-38	37	142	99	3788	81.7	41.5	34.4	9118	265
1	8	WI(RICL3A)-39	38	142	102	4464	82.6	40.7	28.3	10956	387
1	8	WI(RICL3A)-40	39	142	99	3993	82.3	37.6	30.3	10622	351
1	8	WI(RICL3A)-41	40	143	89	4628	82.8	39.8	31.4	11645	371
1	9	WI(RICL3A)-42	41	143	99	4531	82.2	40.9	36.8	11086	301
1	9	WI(RICL3A)-43	42	143	97	4006	82.0	37.2	34.7	10776	311
1	9	WI(RICL3A)-44	43	143	94	3936	80.6	38.8	33.2	10152	306
1	9	WI(RICL3A)-45	44	144	94	3751	82.3	37.1	30.1	10116	336
1	9	WI(RICL3A)-46	45	144	97	4124	81.3	35.9	30.5	11497	377
1	10	WI(RICL3A)-47	46	143	97	5116	81.7	37.4	32.0	13666	427
1	10	WI(RICL3A)-48	47	144	94	4447	81.4	38.4	33.6	11574	344

1	10	WI(RICL3A)-49	48	144	89	4094	80.8	37.5	32.0	10916	341
1	10	WI(RICL3A)-50	49	144	84	4174	81.3	36.2	30.1	11549	384
1	10	WI(RICL3A)-51	50	144	91	4336	81.7	38.4	35.1	11290	322
1	11	WI(RICL3A)-52	51	144	84	4040	82.2	40.3	38.0	10034	264
1	11	WI(RICL3A)-53	52	144	94	3619	79.7	44.9	29.0	8055	278
1	11	WI(RICL3A)-54	53	144	94	4585	81.0	33.8	37.2	13579	365
1	11	WI(RICL3A)-55	54	144	84	3909	81.9	37.1	33.8	10535	312
1	11	WI(RICL3A)-56	55	144	81	4561	82.2	38.3	32.5	11916	367
1	12	WI(RICL3A)-57	56	143	89	4053	82.0	35.8	32.8	11334	346
1	12	WI(RICL3A)-58	57	145	89	3367	80.0	31.6	33.4	10660	319
1	12	WI(RICL3A)-59	58	144	86	4867	81.8	40.4	39.1	12060	308
1	12	WI(RICL3A)-60	59	142	89	3687	81.4	40.6	32.6	9084	279
1	12	WI(RICL3A)-61	60	143	94	4393	81.9	38.0	35.2	11557	328
1	13	WI(RICL3A)-62	61	144	86	3283	81.9	38.3	34.9	8570	246
1	13	WI(RICL3A)-63	62	144	86	4151	81.9	36.0	31.4	11524	367
1	13	WI(RICL3A)-64	63	142	84	2684	81.4	34.5	30.9	7788	252
1	13	WI(RICL3A)-65	64	144	86	3764	82.3	39.8	26.7	9454	354
1	13	WI(RICL3A)-66	65	144	86	4232	81.9	38.9	29.8	10890	365
1	14	WI(RICL3A)-67	66	141	79	3798	82.2	39.3	27.5	9661	351
1	14	WI(RICL3A)-68	67	140	94	3761	81.9	38.0	31.7	9893	312
1	14	WI(RICL3A)-69	68	144	89	4053	80.1	38.0	32.1	10674	333
1	14	WI(RICL3A)-70	69	142	86	3697	81.0	38.1	32.9	9699	295
1	14	WI(RICL3A)-71	70	144	86	3024	80.5	34.9	32.5	8659	266
1	15	WI(RICL3A)-72	71	145	86	3394	81.0	36.4	32.9	9336	284
1	15	WI(RICL3A)-73	72	144	94	4084	82.2	41.4	36.7	9873	269
1	15	WI(RICL3A)-74	73	144	89	3730	82.2	38.6	35.6	9672	272
1	15	WI(RICL3A)-75	74	144	84	3845	82.3	37.5	31.9	10246	321
1	15	WI(RICL3A)-76	75	144	81	3586	81.8	37.7	33.1	9503	287
1	16	WI(RICL3A)-77	76	145	91	2953	80.8	38.1	33.3	7744	233
1	16	WI(RICL3A)-78	77	143	89	3037	78.7	35.9	34.0	8472	249
1	16	WI(RICL3A)-79	78	141	99	3236	80.2	38.4	30.5	8421	276
1	16	WI(RICL3A)-80	79	142	81	3949	82.8	40.3	31.1	9794	315
1	16	WI(RICL3A)-81	80	142	81	3814	82.0	38.1	30.7	10026	327
1	17	WI(RICL3A)-82	81	142	84	3300	81.5	40.3	36.2	8193	226
1	17	WI(RICL3A)-83	82	143	91	3122	80.6	35.0	29.1	8923	307
1	17	WI(RICL3A)-84	83	144	84	3801	81.9	40.1	32.3	9473	293
1	17	WI(RICL3A)-85	84	145	89	3764	81.1	38.3	31.5	9840	312
1	17	WI(RICL3A)-86	85	142	99	2863	81.0	37.0	32.9	7732	235
1	18	WI(RICL3A)-87	86	145	89	3875	81.5	39.0	37.2	9928	267
1	18	WI(RICL3A)-88	87	144	86	3081	81.0	36.6	36.5	8424	231
1	18	WI(RICL3A)-89	88	142	91	3522	81.3	36.4	36.3	9678	267
1	18	WI(RICL3A)-90	89	142	89	3441	80.9	39.0	34.3	8821	257
1	18	WI(RICL3A)-91	90	145	81	3209	81.9	37.4	33.2	8571	258
1	19	WI(CNN3A)	91	144	99	4020	81.1	40.7	38.1	9881	259
1	19	WI(CNN6A)	92	145	97	4195	81.3	39.4	30.0	10646	355
1	19	WI	93	142	89	4524	82.0	36.2	30.9	12504	405
1	19	CNN	94	148	97	3991	79.8	34.4	30.8	13060	424
1	19	CNN(WI3A)	95	145	94	5617	82.2	38.4	33.5	14645	437
1	20	CNN(WI6A)	96	146	89	4410	81.0	40.0	33.2	11016	332
1	20	Pronghorn	97	144	91	.	81.5	38.4	31.3	.	.
1	20	Jagger	98	141	86	6929	81.3	39.3	37.2	17619	474
1	20	Overland	99	145	86	5665	81.5	36.7	41.7	15449	370
1	20	Goodstreak	100	145	94	6199	82.0	40.4	37.2	15354	413

2	15	WI(RICL3A)-1	1	144	89	3905	81.4	34.9	33.6	11186	333
2	17	WI(RICL3A)-2	2	145	86	3421	80.9	36.2	36.9	9448	256
2	7	WI(RICL3A)-3	3	144	81	4124	82.6	39.0	30.3	10571	349
2	12	WI(RICL3A)-4	4	143	86	4494	82.6	39.2	33.1	11469	346
2	14	WI(RICL3A)-5	5	142	97	4016	81.7	39.0	34.0	10290	303
2	11	WI(RICL3A)-6	6	144	91	4588	81.9	38.7	30.1	11864	394
2	2	WI(RICL3A)-7	7	144	89	4026	82.2	37.3	28.9	10804	374
2	18	WI(RICL3A)-8	8	145	86	3004	81.4	37.9	32.6	7923	243
2	14	WI(RICL3A)-9	9	144	89	4121	80.8	37.7	35.0	10942	313
2	3	WI(RICL3A)-10	10	142	89	4413	82.0	39.4	39.7	11217	283
2	5	WI(RICL3A)-11	11	144	84	4437	81.9	40.2	32.3	11049	342
2	17	WI(RICL3A)-12	12	144	81	4205	81.5	38.5	34.3	10917	318
2	16	WI(RICL3A)-13	13	144	91	4016	81.8	37.4	33.7	10742	319
2	7	WI(RICL3A)-14	14	144	86	4174	80.8	38.8	36.9	10757	292
2	8	WI(RICL3A)-15	15	142	86	3441	80.9	39.9	34.8	8615	248
2	8	WI(RICL3A)-16	16	144	84	4205	81.4	42.6	41.7	9861	236
2	18	WI(RICL3A)-17	17	144	91	3539	81.1	40.3	35.9	8791	245
2	10	WI(RICL3A)-18	18	145	89	3276	82.0	39.5	36.2	8294	229
2	15	WI(RICL3A)-19	19	144	81	3899	80.0	38.1	33.6	10242	305
2	1	WI(RICL3A)-20	20	143	97	4144	82.0	38.9	32.5	10664	328
2	8	WI(RICL3A)-21	21	144	84	4003	82.2	40.0	36.6	10007	273
2	2	WI(RICL3A)-22	22	142	86	3700	80.6	35.3	32.6	10489	322
2	6	WI(RICL3A)-23	23	142	86	3592	81.0	35.9	33.6	10001	298
2	11	WI(RICL3A)-25	24	144	89	4359	83.5	39.3	33.4	11106	333
2	20	WI(RICL3A)-26	25	144	94	3323	81.0	38.1	31.9	8718	273
2	19	WI(RICL3A)-27	26	144	97	3999	81.1	40.6	33.6	9845	293
2	12	WI(RICL3A)-28	27	142	89	3727	81.4	37.8	30.6	9874	323
2	8	WI(RICL3A)-29	28	142	91	3730	81.3	40.6	34.3	9199	268
2	13	WI(RICL3A)-30	29	143	91	4332	81.9	39.8	38.2	10874	285
2	2	WI(RICL3A)-31	30	144	86	4087	82.2	37.7	31.6	10853	343
2	6	WI(RICL3A)-32	31	144	89	4383	81.9	38.2	34.7	11461	330
2	19	WI(RICL3A)-33	32	144	94	4292	82.2	39.4	30.1	10884	362
2	7	WI(RICL3A)-34	33	145	97	3899	80.6	36.9	31.7	10563	333
2	4	WI(RICL3A)-35	34	143	97	3502	81.0	35.6	31.8	9828	309
2	18	WI(RICL3A)-36	35	144	91	3566	81.3	32.3	36.1	11030	306
2	1	WI(RICL3A)-37	36	144	99	3878	81.3	37.6	35.4	10307	291
2	12	WI(RICL3A)-38	37	143	94	3468	81.7	38.3	28.7	9065	316
2	11	WI(RICL3A)-39	38	143	107	3404	82.7	39.8	34.4	8547	248
2	10	WI(RICL3A)-40	39	144	91	3545	81.1	37.8	35.4	9373	265
2	5	WI(RICL3A)-41	40	144	86	3993	82.4	37.7	31.6	10594	335
2	3	WI(RICL3A)-42	41	143	99	4450	81.8	37.7	30.6	11800	386
2	1	WI(RICL3A)-43	42	143	94	3576	81.5	36.9	34.0	9702	285
2	19	WI(RICL3A)-44	43	144	89	3952	80.6	37.1	31.5	10641	338
2	20	WI(RICL3A)-45	44	144	94	3932	81.3	39.4	30.4	9970	328
2	17	WI(RICL3A)-46	45	145	91	3835	81.0	38.4	32.9	9981	303
2	3	WI(RICL3A)-47	46	144	89	4343	82.0	38.0	29.5	11428	387
2	15	WI(RICL3A)-48	47	144	89	3714	79.6	38.3	32.4	9695	299
2	13	WI(RICL3A)-49	48	143	86	4151	80.9	38.0	34.7	10937	315
2	5	WI(RICL3A)-50	49	144	84	3855	81.7	37.3	32.3	10324	320
2	6	WI(RICL3A)-51	50	145	84	3892	82.0	38.8	36.0	10043	279
2	16	WI(RICL3A)-52	51	145	79	4010	82.6	39.9	39.0	10043	258
2	9	WI(RICL3A)-53	52	143	91	4309	78.9	30.7	29.7	14032	472
2	15	WI(RICL3A)-54	53	144	89	4258	79.6	37.4	26.6	11384	428

2	11	WI(RICL3A)-55	54	145	84	3646	82.0	40.3	41.8	9040	216
2	19	WI(RICL3A)-56	55	144	89	4353	82.3	37.6	33.3	11577	348
2	10	WI(RICL3A)-57	56	142	86	3091	81.9	36.1	29.8	8561	287
2	3	WI(RICL3A)-58	57	144	86	4195	81.3	35.3	37.7	11890	315
2	7	WI(RICL3A)-59	58	144	84	3993	82.0	38.3	33.1	10423	315
2	20	WI(RICL3A)-60	59	142	94	3347	80.8	39.9	28.8	8396	292
2	13	WI(RICL3A)-61	60	142	91	3818	82.0	37.6	30.8	10163	330
2	4	WI(RICL3A)-62	61	144	86	4228	82.0	37.6	29.3	11252	384
2	16	WI(RICL3A)-63	62	143	86	4245	81.7	38.3	37.0	11092	300
2	2	WI(RICL3A)-64	63	142	84	3518	81.9	39.7	30.0	8855	295
2	15	WI(RICL3A)-65	64	144	89	4336	82.0	39.2	35.3	11051	313
2	10	WI(RICL3A)-66	65	144	91	3552	81.8	37.7	35.5	9424	265
2	6	WI(RICL3A)-67	66	142	81	3599	82.6	36.6	28.7	9838	343
2	14	WI(RICL3A)-68	67	141	89	3488	82.2	37.4	35.6	9330	262
2	1	WI(RICL3A)-69	68	145	91	3794	81.0	38.1	32.8	9948	303
2	16	WI(RICL3A)-70	69	142	86	3532	80.9	38.1	30.4	9264	305
2	13	WI(RICL3A)-71	70	144	91	3841	81.5	37.4	37.7	10285	273
2	5	WI(RICL3A)-72	71	145	84	3831	81.7	39.3	36.5	9738	267
2	7	WI(RICL3A)-73	72	144	89	4359	81.7	37.0	30.4	11770	387
2	2	WI(RICL3A)-74	73	144	86	4164	82.0	40.0	33.1	10403	314
2	1	WI(RICL3A)-75	74	145	84	3922	81.7	36.1	30.1	10861	361
2	9	WI(RICL3A)-76	75	142	89	3962	81.7	38.0	35.8	10431	291
2	8	WI(RICL3A)-77	76	144	89	3888	82.3	38.2	32.3	10170	315
2	3	WI(RICL3A)-78	77	144	89	3555	79.1	36.8	33.7	9671	287
2	9	WI(RICL3A)-79	78	140	102	3714	81.0	41.5	38.4	8940	233
2	4	WI(RICL3A)-80	79	142	81	4141	82.8	39.5	31.0	10479	338
2	12	WI(RICL3A)-81	80	142	84	3804	82.0	35.2	28.8	10805	375
2	16	WI(RICL3A)-82	81	142	84	3438	81.5	41.4	32.4	8312	257
2	20	WI(RICL3A)-83	82	141	89	3936	81.0	37.7	27.6	10434	378
2	9	WI(RICL3A)-84	83	144	89	4235	81.8	36.4	34.2	11624	340
2	18	WI(RICL3A)-85	84	144	84	3347	80.2	39.0	37.1	8575	231
2	12	WI(RICL3A)-86	85	142	94	3851	82.4	39.1	29.9	9851	329
2	4	WI(RICL3A)-87	86	144	89	4766	81.5	38.8	31.9	12302	386
2	5	WI(RICL3A)-88	87	144	79	3683	81.5	38.1	34.3	9666	282
2	14	WI(RICL3A)-89	88	142	89	3737	82.0	37.0	34.8	10105	290
2	19	WI(RICL3A)-90	89	142	91	3697	81.1	37.5	29.4	9853	335
2	20	WI(RICL3A)-91	90	144	84	3784	82.7	40.0	33.7	9460	281
2	14	WI(CNN3A)	91	144	101	3508	80.2	40.2	34.4	8739	254
2	10	WI(CNN6A)	92	146	94	3764	81.8	41.3	35.9	9124	254
2	9	WI	93	143	84	3912	82.4	38.6	33.9	10131	299
2	6	CNN	94	147	99	4188	80.1	35.0	30.4	11954	393
2	17	CNN(WI3A)	95	146	86	5469	74.2	39.8	34.6	13733	397
2	4	CNN(WI6A)	96	145	86	4380	81.1	39.4	30.1	11115	369
2	11	Pronghorn	97	144	86	5146	81.5	38.7	35.1	13302	379
2	13	Jagger	98	140	86	6664	82.4	39.1	38.5	17024	442
2	17	Overland	99	146	84	4524	80.0	38.7	45.0	11694	260
2	18	Goodstreak	100	144	97	5611	81.5	37.7	36.1	14882	412
3	15	WI(RICL3A)-1	1	145	94	4316	81.8	40.0	38.3	10789	282
3	5	WI(RICL3A)-2	2	144	94	3932	81.8	40.5	36.8	9699	264
3	14	WI(RICL3A)-3	3	144	81	4168	82.7	40.6	33.7	10267	305
3	17	WI(RICL3A)-4	4	142	84	4935	81.4	41.9	37.3	11791	316
3	13	WI(RICL3A)-5	5	141	97	3391	80.6	39.3	33.6	8637	257
3	18	WI(RICL3A)-6	6	143	91	4995	81.9	39.9	31.3	12518	400

3	17	WI(RICL3A)-7	7	143	91	4131	82.4	36.3	28.6	11370	398
3	11	WI(RICL3A)-8	8	144	89	3690	81.8	38.8	35.1	9516	271
3	2	WI(RICL3A)-9	9	144	89	3848	80.8	36.3	34.6	10609	307
3	20	WI(RICL3A)-10	10	142	91	4887	82.2	41.9	37.5	11659	311
3	10	WI(RICL3A)-11	11	143	91	4575	82.4	39.7	35.0	11519	329
3	3	WI(RICL3A)-12	12	144	89	4255	82.3	37.5	33.7	11354	337
3	12	WI(RICL3A)-13	13	143	91	4141	82.7	36.7	31.7	11286	356
3	9	WI(RICL3A)-14	14	144	86	4137	80.6	38.3	37.6	10803	287
3	4	WI(RICL3A)-15	15	142	94	4144	81.3	37.9	40.0	10934	273
3	7	WI(RICL3A)-16	16	144	86	4504	80.5	38.0	33.1	11860	358
3	5	WI(RICL3A)-17	17	144	97	3754	82.2	39.3	38.3	9547	249
3	10	WI(RICL3A)-18	18	144	97	4188	81.4	40.7	34.8	10292	296
3	2	WI(RICL3A)-19	19	144	86	4228	82.2	40.2	34.0	10532	310
3	20	WI(RICL3A)-20	20	142	102	4306	82.8	38.6	31.1	11168	359
3	16	WI(RICL3A)-21	21	145	89	4023	81.8	40.2	35.4	10001	283
3	1	WI(RICL3A)-22	22	142	86	3966	81.0	37.1	34.6	10687	309
3	3	WI(RICL3A)-23	23	142	89	3582	81.1	38.3	33.6	9360	279
3	19	WI(RICL3A)-25	24	144	89	4306	82.7	38.6	29.7	11149	375
3	8	WI(RICL3A)-26	25	144	97	4235	81.1	40.1	32.2	10563	328
3	2	WI(RICL3A)-27	26	144	94	4104	81.4	38.4	33.2	10694	322
3	11	WI(RICL3A)-28	27	141	94	4043	81.0	38.4	34.3	10538	307
3	20	WI(RICL3A)-29	28	142	94	4225	80.9	40.2	28.7	10516	366
3	13	WI(RICL3A)-30	29	143	91	3135	81.9	36.4	32.2	8613	267
3	6	WI(RICL3A)-31	30	143	86	4676	82.9	38.9	32.5	12012	370
3	18	WI(RICL3A)-32	31	144	91	4945	81.3	42.9	36.9	11526	312
3	17	WI(RICL3A)-33	32	143	94	4874	82.3	38.1	30.4	12784	421
3	20	WI(RICL3A)-34	33	144	99	4400	81.0	38.8	37.6	11331	301
3	19	WI(RICL3A)-35	34	142	99	4114	81.4	38.9	31.4	10588	337
3	15	WI(RICL3A)-36	35	143	94	4433	80.6	36.9	38.8	12004	309
3	14	WI(RICL3A)-37	36	143	97	3714	81.0	37.8	36.0	9816	273
3	9	WI(RICL3A)-38	37	142	97	4279	82.2	40.1	33.5	10681	319
3	12	WI(RICL3A)-39	38	141	109	4507	82.7	41.3	34.5	10905	316
3	3	WI(RICL3A)-40	39	144	89	3384	81.1	35.0	35.4	9676	273
3	8	WI(RICL3A)-41	40	144	86	4272	82.8	39.3	31.7	10868	343
3	15	WI(RICL3A)-42	41	142	102	5042	82.4	39.5	32.4	12753	394
3	18	WI(RICL3A)-43	42	142	99	.	.	39.2	30.4	.	.
3	5	WI(RICL3A)-44	43	142	97	4568	81.1	38.0	37.2	12026	323
3	16	WI(RICL3A)-45	44	143	99	4615	81.8	40.5	31.3	11401	364
3	19	WI(RICL3A)-46	45	144	94	4753	82.0	42.1	32.9	11299	343
3	7	WI(RICL3A)-47	46	144	89	4676	81.7	35.2	27.0	13288	492
3	19	WI(RICL3A)-48	47	143	97	4117	82.6	41.5	31.0	9917	320
3	4	WI(RICL3A)-49	48	144	91	4635	80.8	38.7	35.5	11976	337
3	16	WI(RICL3A)-50	49	144	86	4322	81.9	36.0	29.2	12020	412
3	5	WI(RICL3A)-51	50	144	89	4349	82.2	39.2	29.9	11105	371
3	3	WI(RICL3A)-52	51	144	89	4057	82.0	37.2	37.5	10913	291
3	20	WI(RICL3A)-53	52	143	97	4514	80.6	37.5	35.8	12033	336
3	18	WI(RICL3A)-54	53	143	97	4158	81.5	39.1	34.2	10643	311
3	10	WI(RICL3A)-55	54	143	89	2741	81.3	39.2	38.6	6994	181
3	7	WI(RICL3A)-56	55	144	91	4871	81.1	39.1	33.1	12469	377
3	6	WI(RICL3A)-57	56	141	97	4235	82.8	43.4	33.7	9762	290
3	17	WI(RICL3A)-58	57	143	91	4053	81.9	35.8	31.3	11317	362
3	11	WI(RICL3A)-59	58	143	89	4864	82.4	41.1	31.2	11837	379
3	9	WI(RICL3A)-60	59	142	97	3387	81.5	41.3	32.1	8212	256

3	12	WI(RICL3A)-61	60	142	97	3387	81.8	39.8	26.1	8517	326
3	9	WI(RICL3A)-62	61	143	91	4087	82.3	39.6	33.4	10333	309
3	8	WI(RICL3A)-63	62	144	81	4558	82.0	37.0	33.9	12312	363
3	14	WI(RICL3A)-64	63	141	86	3690	80.6	40.0	27.9	9233	331
3	13	WI(RICL3A)-65	64	142	91	4114	82.8	40.0	29.3	10276	351
3	1	WI(RICL3A)-66	65	144	89	3724	82.0	39.5	35.6	9422	265
3	15	WI(RICL3A)-67	66	140	86	4060	82.9	39.4	31.1	10316	332
3	9	WI(RICL3A)-68	67	141	94	3182	81.8	39.7	34.4	8013	233
3	17	WI(RICL3A)-69	68	144	99	4413	81.5	38.4	32.6	11482	352
3	11	WI(RICL3A)-70	69	140	94	4417	81.7	40.2	28.0	10983	392
3	14	WI(RICL3A)-71	70	142	94	3394	81.0	37.4	41.4	9065	219
3	7	WI(RICL3A)-72	71	144	91	4369	80.5	39.4	35.9	11086	309
3	2	WI(RICL3A)-73	72	144	89	3858	81.8	37.7	39.8	10230	257
3	15	WI(RICL3A)-74	73	142	91	4924	82.6	40.3	35.0	12224	349
3	13	WI(RICL3A)-75	74	143	89	3818	82.7	39.8	32.4	9596	296
3	5	WI(RICL3A)-76	75	143	89	4043	82.8	40.8	34.3	9920	289
3	18	WI(RICL3A)-77	76	143	94	3925	81.7	42.9	35.0	9147	261
3	10	WI(RICL3A)-78	77	143	94	3643	79.6	38.1	38.8	9563	246
3	19	WI(RICL3A)-79	78	139	107	4363	81.5	41.6	29.0	10482	361
3	3	WI(RICL3A)-80	79	142	84	3606	81.9	39.1	32.8	9219	281
3	8	WI(RICL3A)-81	80	142	86	4403	81.8	37.2	33.2	11827	356
3	6	WI(RICL3A)-82	81	141	89	4292	82.8	43.6	33.7	9853	292
3	14	WI(RICL3A)-83	82	142	94	2876	81.1	40.0	26.7	7183	269
3	2	WI(RICL3A)-84	83	144	81	4104	82.0	37.1	30.7	11071	361
3	13	WI(RICL3A)-85	84	143	94	4306	82.6	40.5	36.2	10625	293
3	1	WI(RICL3A)-86	85	142	89	3283	81.9	35.6	36.0	9233	256
3	12	WI(RICL3A)-87	86	143	97	4161	81.0	40.6	39.1	10258	262
3	1	WI(RICL3A)-88	87	144	79	3973	81.1	35.8	33.0	11091	336
3	6	WI(RICL3A)-89	88	141	99	4094	82.8	39.1	31.1	10478	337
3	11	WI(RICL3A)-90	89	143	94	4026	81.8	38.8	25.6	10391	406
3	4	WI(RICL3A)-91	90	144	89	3946	81.3	40.6	36.6	9725	266
3	12	WI(CNN3A)	91	145	102	3404	81.3	38.0	31.9	8960	281
3	4	WI(CNN6A)	92	145	99	3771	80.8	39.3	30.5	9592	314
3	16	WI	93	143	84	4632	82.2	38.7	34.4	11980	348
3	10	CNN	94	146	98	3609	78.4	32.5	35.5	12034	339
3	7	CNN(WI3A)	95	145	91	4898	81.1	35.8	30.2	13670	453
3	16	CNN(WI6A)	96	145	94	4322	80.5	41.4	36.2	10438	288
3	4	Pronghorn	97	143	94	5227	81.7	40.2	37.2	13016	350
3	1	Jagger	98	140	84	5846	81.9	39.9	43.7	14657	335
3	8	Overland	99	145	89	5180	81.0	35.9	40.6	14435	356
3	6	Goodstreak	100	144	102	6701	82.3	41.1	41.4	16299	394

Appendix 9. Field dataset for anthesis date (AD), plant height (PHT), grain yield (GYLD), grain volume weight (GVW), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), and spikes per square meter (SPSM), evaluated in WI(RICLs-3A) mapping population at Mead, NE during 2009 cropping season.

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	1	WI(RICL3A)-1	1	147	99	3685	76.0	38.8	32.0	9486	296
1	1	WI(RICL3A)-2	2	146	102	3674	75.1	38.6	31.6	9510	301
1	1	WI(RICL3A)-3	3	145	104	4636	76.1	41.8	33.9	11100	327
1	1	WI(RICL3A)-4	4	145	104	3946	76.0	41.3	28.7	9566	333
1	1	WI(RICL3A)-5	5	145	112	3841	74.4	36.4	30.9	10550	341
1	2	WI(RICL3A)-6	6	145	104	3868	75.6	41.2	33.0	9386	284
1	2	WI(RICL3A)-7	7	146	104	3950	76.0	38.6	28.0	10240	366
1	2	WI(RICL3A)-8	8	146	102	3821	75.3	33.4	34.3	11455	334
1	2	WI(RICL3A)-9	9	146	107	3246	73.9	39.9	33.3	8128	244
1	2	WI(RICL3A)-10	10	144	94	3073	76.0	41.0	31.5	7498	238
1	3	WI(RICL3A)-11	11	144	97	3134	74.9	39.3	30.0	7975	266
1	3	WI(RICL3A)-12	12	145	94	3103	75.3	40.1	31.3	7734	247
1	3	WI(RICL3A)-13	13	146	99	2944	75.1	39.4	35.3	7476	212
1	3	WI(RICL3A)-14	14	147	97	2713	73.3	39.0	33.8	6951	206
1	3	WI(RICL3A)-15	15	145	97	2692	75.5	39.0	30.7	6905	225
1	4	WI(RICL3A)-16	16	147	99	2753	74.6	38.7	30.6	7110	232
1	4	WI(RICL3A)-17	17	147	104	2583	73.3	37.5	36.8	6894	187
1	4	WI(RICL3A)-18	18	147	102	2563	72.5	39.7	28.7	6464	225
1	4	WI(RICL3A)-19	19	146	102	3270	75.1	36.1	28.5	9057	318
1	4	WI(RICL3A)-20	20	145	97	3277	76.0	37.1	28.2	8834	313
1	5	WI(RICL3A)-21	21	146	102	3253	74.0	40.8	32.2	7978	248
1	5	WI(RICL3A)-22	22	142	94	2672	73.5	38.4	29.1	6967	239
1	5	WI(RICL3A)-23	23	142	97	3739	74.8	38.1	34.2	9821	287
1	5	WI(RICL3A)-25	24	143	102	4188	76.0	38.4	34.5	10920	317
1	5	WI(RICL3A)-26	25	146	112	3341	74.3	37.1	35.4	9009	254
1	6	WI(RICL3A)-27	26	146	109	3035	73.5	39.0	34.5	7780	226
1	6	WI(RICL3A)-28	27	144	104	3092	73.5	39.1	35.4	7903	223
1	6	WI(RICL3A)-29	28	142	94	3980	75.3	41.7	32.2	9557	297
1	6	WI(RICL3A)-30	29	145	104	4591	75.3	38.1	33.6	12060	359
1	6	WI(RICL3A)-31	30	145	102	3478	75.5	36.7	35.2	9476	269
1	7	WI(RICL3A)-32	31	146	104	3513	73.5	34.3	31.9	10235	321
1	7	WI(RICL3A)-33	32	146	104	4221	76.5	33.8	29.9	12484	418
1	7	WI(RICL3A)-34	33	146	104	3848	74.8	35.6	33.5	10796	322
1	7	WI(RICL3A)-35	34	146	112	3813	73.9	37.0	30.2	10318	342
1	7	WI(RICL3A)-36	35	146	107	3556	73.8	36.7	29.8	9686	325
1	8	WI(RICL3A)-37	36	147	104	3502	73.8	39.2	36.2	8926	247
1	8	WI(RICL3A)-38	37	146	102	3645	75.3	39.9	30.2	9144	303
1	8	WI(RICL3A)-39	38	146	102	3945	76.5	39.6	30.8	9960	323
1	8	WI(RICL3A)-40	39	146	99	3210	76.0	35.7	32.8	8991	274
1	8	WI(RICL3A)-41	40	146	102	3607	73.6	39.9	33.0	9037	274
1	9	WI(RICL3A)-42	41	146	99	3175	75.5	37.6	31.6	8437	267
1	9	WI(RICL3A)-43	42	147	99	2844	73.8	36.2	28.7	7863	274
1	9	WI(RICL3A)-44	43	146	102	2821	74.0	36.4	34.1	7757	227
1	9	WI(RICL3A)-45	44	147	97	3093	73.8	37.0	34.7	8352	241
1	9	WI(RICL3A)-46	45	146	104	4276	76.6	41.5	38.2	10311	270
1	10	WI(RICL3A)-47	46	145	104	4035	76.0	40.4	36.0	9982	277
1	10	WI(RICL3A)-48	47	145	102	4163	75.2	40.7	33.8	10226	303

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	10	WI(RICL3A)-49	48	146	107	3867	74.2	36.6	28.8	10567	367
1	10	WI(RICL3A)-50	49	146	94	3552	74.4	37.5	32.8	9465	289
1	10	WI(RICL3A)-51	50	144	99	3202	74.6	39.9	32.5	8017	247
1	11	WI(RICL3A)-52	51	146	99	3933	75.5	40.8	35.0	9647	276
1	11	WI(RICL3A)-53	52	147	109	2377	67.1	29.4	31.2	8097	260
1	11	WI(RICL3A)-54	53	147	102	3148	73.3	36.5	29.0	8622	297
1	11	WI(RICL3A)-55	54	146	102	3804	75.8	38.0	36.8	10007	272
1	11	WI(RICL3A)-56	55	146	97	3532	75.7	41.1	36.6	8601	235
1	12	WI(RICL3A)-57	56	143	104	4023	76.4	38.2	32.2	10523	327
1	12	WI(RICL3A)-58	57	146	99	3495	75.2	38.0	29.9	9199	308
1	12	WI(RICL3A)-59	58	145	97	3925	75.7	40.4	34.0	9707	285
1	12	WI(RICL3A)-60	59	144	91	2778	74.4	39.3	30.8	7078	230
1	12	WI(RICL3A)-61	60	143	91	3182	75.1	39.7	30.6	8008	262
1	13	WI(RICL3A)-62	61	146	94	2923	72.2	38.2	32.3	7657	237
1	13	WI(RICL3A)-63	62	147	89	2728	72.2	37.8	36.0	7221	201
1	13	WI(RICL3A)-64	63	143	91	3448	76.5	38.7	29.5	8914	302
1	13	WI(RICL3A)-65	64	147	94	2920	74.7	41.2	33.0	7090	215
1	13	WI(RICL3A)-66	65	147	91	2977	75.8	41.3	33.2	7204	217
1	14	WI(RICL3A)-67	66	146	86	2960	75.8	39.2	29.2	7555	259
1	14	WI(RICL3A)-68	67	142	97	2859	76.5	40.2	31.3	7114	227
1	14	WI(RICL3A)-69	68	144	104	2826	74.0	36.9	33.3	7662	230
1	14	WI(RICL3A)-70	69	142	99	3276	75.6	39.7	31.8	8262	260
1	14	WI(RICL3A)-71	70	147	104	2718	72.0	32.9	30.2	8266	274
1	15	WI(RICL3A)-72	71	146	99	3216	74.4	38.9	35.6	8266	232
1	15	WI(RICL3A)-73	72	146	104	3539	74.8	37.6	32.2	9401	292
1	15	WI(RICL3A)-74	73	145	102	3340	74.8	41.0	34.6	8150	236
1	15	WI(RICL3A)-75	74	145	102	3522	75.7	39.8	35.5	8842	249
1	15	WI(RICL3A)-76	75	145	99	3280	75.3	40.8	32.1	8030	250
1	16	WI(RICL3A)-77	76	146	91	2889	74.3	39.0	35.5	7417	209
1	16	WI(RICL3A)-78	77	145	89	2408	72.4	37.8	35.0	6376	182
1	16	WI(RICL3A)-79	78	144	94	3382	73.5	37.5	30.4	9018	297
1	16	WI(RICL3A)-80	79	142	94	3858	75.3	38.7	38.5	9982	259
1	16	WI(RICL3A)-81	80	142	89	4254	74.7	37.9	31.1	11240	361
1	17	WI(RICL3A)-82	81	143	91	4142	76.0	41.0	32.0	10095	315
1	17	WI(RICL3A)-83	82	143	97	4215	75.1	39.5	30.3	10661	352
1	17	WI(RICL3A)-84	83	145	104	4336	74.8	36.9	33.4	11764	352
1	17	WI(RICL3A)-85	84	146	104	3647	75.6	40.5	30.9	9015	292
1	17	WI(RICL3A)-86	85	145	97	3434	75.5	40.7	27.9	8435	302
1	18	WI(RICL3A)-87	86	146	107	3397	72.1	34.8	30.5	9765	320
1	18	WI(RICL3A)-88	87	145	102	4314	74.9	36.1	31.8	11940	375
1	18	WI(RICL3A)-89	88	142	94	3974	76.1	39.6	25.1	10035	400
1	18	WI(RICL3A)-90	89	142	94	4004	75.6	39.8	29.7	10053	338
1	18	WI(RICL3A)-91	90	145	102	3419	74.3	39.7	31.2	8616	276
1	19	WI(CNN3A)	91	147	104	3810	74.8	40.3	26.3	9445	359
1	19	WI(CNN6A)	92	147	104	3660	74.2	40.8	35.0	8964	256
1	19	WI	93	145	99	4336	75.8	42.1	33.5	10294	307
1	19	CNN	94	148	105	3353	72.6	34.2	33.3	11256	338
1	19	CNN(WI3A)	95	148	102	4684	73.5	31.5	37.2	14869	400
1	20	CNN(WI6A)	96	147	107	4026	73.8	36.0	33.7	11175	332
1	20	Pronghorn	97	146	91	6217	77.5	37.0	32.9	16807	511
1	20	Jagger	98	143	89	5154	76.4	37.3	37.2	13813	371
1	20	Overland	99	147	94	5998	76.0	37.8	35.9	15879	442

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	20	Goodstreak	100	147	97	6213	75.8	37.2	36.6	16708	457
2	12	WI(RICL3A)-1	1	146	94	2874	73.8	36.7	32.6	7839	240
2	18	WI(RICL3A)-2	2	145	107	3812	74.9	41.0	28.3	9300	329
2	17	WI(RICL3A)-3	3	144	97	3556	74.8	41.6	31.3	8542	273
2	15	WI(RICL3A)-4	4	145	99	4724	76.1	40.5	33.6	11680	348
2	2	WI(RICL3A)-5	5	146	107	3633	73.9	37.8	29.3	9615	328
2	9	WI(RICL3A)-6	6	145	107	2749	74.6	38.9	32.1	7064	220
2	18	WI(RICL3A)-7	7	144	107	3867	75.7	43.1	33.0	8981	272
2	16	WI(RICL3A)-8	8	145	102	3813	75.7	40.6	32.2	9402	292
2	4	WI(RICL3A)-9	9	145	107	3108	73.9	40.3	32.0	7722	241
2	10	WI(RICL3A)-10	10	145	89	3135	74.2	34.6	32.9	9072	276
2	17	WI(RICL3A)-11	11	144	97	3721	75.2	41.5	35.0	8977	256
2	8	WI(RICL3A)-12	12	145	97	3214	73.6	35.7	29.6	8992	304
2	15	WI(RICL3A)-13	13	144	104	3868	75.5	40.6	32.9	9539	290
2	7	WI(RICL3A)-14	14	146	91	.	70.2	36.8	32.1	.	.
2	12	WI(RICL3A)-15	15	144	91	4144	74.8	38.0	31.7	10900	344
2	4	WI(RICL3A)-16	16	146	102	2977	71.5	42.6	36.1	6987	194
2	2	WI(RICL3A)-17	17	146	107	3095	74.3	38.9	33.7	7955	236
2	6	WI(RICL3A)-18	18	146	107	3455	74.2	33.2	34.6	10403	301
2	9	WI(RICL3A)-19	19	146	107	3083	74.8	37.5	33.9	8229	243
2	20	WI(RICL3A)-20	20	144	97	3257	76.2	40.3	29.1	8086	278
2	7	WI(RICL3A)-21	21	147	102	3109	73.9	38.5	32.9	8086	246
2	17	WI(RICL3A)-22	22	142	102	3308	73.5	38.3	32.7	8647	264
2	10	WI(RICL3A)-23	23	143	99	3447	74.3	37.1	30.9	9286	301
2	2	WI(RICL3A)-25	24	144	109	3391	76.1	41.6	32.2	8160	253
2	13	WI(RICL3A)-26	25	146	107	3360	73.4	36.0	31.3	9331	298
2	6	WI(RICL3A)-27	26	146	109	3924	74.2	34.6	36.2	11327	313
2	14	WI(RICL3A)-28	27	144	102	3218	74.8	39.0	32.1	8258	257
2	11	WI(RICL3A)-29	28	143	99	.	72.6	35.2	32.6	.	.
2	13	WI(RICL3A)-30	29	145	107	4006	74.2	40.5	31.9	9882	310
2	20	WI(RICL3A)-31	30	145	104	3454	75.7	39.2	31.2	8811	282
2	6	WI(RICL3A)-32	31	146	99	3303	74.6	36.4	33.4	9073	272
2	17	WI(RICL3A)-33	32	144	102	4368	75.7	41.3	34.6	10577	306
2	2	WI(RICL3A)-34	33	146	109	3357	73.6	37.0	40.1	9077	226
2	13	WI(RICL3A)-35	34	146	104	3226	73.5	38.6	31.6	8362	265
2	9	WI(RICL3A)-36	35	146	104	3492	74.3	39.1	29.2	8929	306
2	18	WI(RICL3A)-37	36	145	107	3560	72.6	36.2	33.0	9831	298
2	11	WI(RICL3A)-38	37	146	104	3965	72.9	38.9	34.1	10182	299
2	1	WI(RICL3A)-39	38	146	104	3915	75.5	42.4	31.3	9228	295
2	3	WI(RICL3A)-40	39	146	102	2657	74.7	36.4	29.5	7292	247
2	12	WI(RICL3A)-41	40	145	99	3621	74.3	37.6	35.2	9634	274
2	19	WI(RICL3A)-42	41	144	104	3477	76.0	35.9	28.0	9688	346
2	8	WI(RICL3A)-43	42	145	107	3548	75.3	38.3	29.0	9254	319
2	14	WI(RICL3A)-44	43	146	102	2964	71.2	36.9	32.9	8033	244
2	5	WI(RICL3A)-45	44	146	94	3458	75.6	33.2	31.3	10427	333
2	4	WI(RICL3A)-46	45	146	107	3589	74.3	39.8	33.7	9020	268
2	11	WI(RICL3A)-47	46	145	94	3147	74.2	37.0	34.5	8494	246
2	14	WI(RICL3A)-48	47	145	99	3284	73.6	36.8	30.7	8929	291
2	15	WI(RICL3A)-49	48	145	109	3879	74.2	39.9	34.8	9718	279
2	5	WI(RICL3A)-50	49	146	99	3307	75.2	38.2	32.1	8657	270
2	8	WI(RICL3A)-51	50	143	102	3616	75.1	36.1	29.2	10008	343
2	14	WI(RICL3A)-52	51	145	102	3476	74.0	39.3	38.5	8839	230

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
2	12	WI(RICL3A)-53	52	145	107	2710	70.5	33.5	35.0	8101	231
2	15	WI(RICL3A)-54	53	145	107	3465	73.4	36.3	32.1	9556	298
2	3	WI(RICL3A)-55	54	146	102	3226	75.3	38.5	34.9	8370	240
2	11	WI(RICL3A)-56	55	145	94	2816	74.3	36.3	36.1	7749	215
2	1	WI(RICL3A)-57	56	142	94	5416	76.0	41.1	29.3	13170	449
2	3	WI(RICL3A)-58	57	147	104	3421	74.8	36.2	35.1	9455	269
2	19	WI(RICL3A)-59	58	145	91	.	73.1	30.9	29.8	.	.
2	20	WI(RICL3A)-60	59	142	97	3237	73.9	41.2	31.3	7854	251
2	8	WI(RICL3A)-61	60	144	99	3278	74.6	38.1	31.3	8615	275
2	4	WI(RICL3A)-62	61	145	107	3835	76.1	38.1	39.0	10078	258
2	16	WI(RICL3A)-63	62	146	97	3871	75.2	40.6	31.5	9527	302
2	10	WI(RICL3A)-64	63	142	94	3199	73.9	41.7	33.6	7678	229
2	13	WI(RICL3A)-65	64	145	102	3835	74.3	36.9	30.7	10392	338
2	5	WI(RICL3A)-66	65	147	94	3488	73.8	40.2	33.4	8669	260
2	5	WI(RICL3A)-67	66	145	94	3212	76.5	39.5	29.4	8135	277
2	19	WI(RICL3A)-68	67	143	94	3521	73.1	36.3	29.6	9703	328
2	9	WI(RICL3A)-69	68	146	104	2929	73.9	39.4	35.6	7437	209
2	4	WI(RICL3A)-70	69	143	102	3781	73.6	40.5	33.2	9326	281
2	20	WI(RICL3A)-71	70	145	104	2579	73.4	35.7	29.9	7221	242
2	11	WI(RICL3A)-72	71	146	97	3301	72.5	31.3	34.7	10556	304
2	20	WI(RICL3A)-73	72	146	104	4403	75.1	40.1	32.6	10981	337
2	6	WI(RICL3A)-74	73	145	104	3576	75.5	41.6	32.3	8593	266
2	3	WI(RICL3A)-75	74	146	97	3404	75.6	40.3	29.7	8453	285
2	19	WI(RICL3A)-76	75	144	102	3544	75.8	42.1	33.2	8411	253
2	12	WI(RICL3A)-77	76	146	97	2601	74.8	39.4	34.8	6599	190
2	18	WI(RICL3A)-78	77	143	89	2745	72.6	33.5	34.3	8201	239
2	2	WI(RICL3A)-79	78	145	99	4262	74.4	41.3	32.3	10327	320
2	9	WI(RICL3A)-80	79	143	99	.	73.6	36.7	36.5	.	.
2	16	WI(RICL3A)-81	80	142	97	4456	76.5	40.1	34.3	11106	324
2	7	WI(RICL3A)-82	81	144	89	.	70.0	35.9	36.6	.	.
2	10	WI(RICL3A)-83	82	142	99	3162	74.6	39.3	25.8	8044	312
2	1	WI(RICL3A)-84	83	146	99	4650	75.2	43.2	35.9	10756	300
2	17	WI(RICL3A)-85	84	145	102	3146	74.3	38.5	32.0	8164	255
2	16	WI(RICL3A)-86	85	144	99	3616	76.2	39.7	31.1	9121	293
2	6	WI(RICL3A)-87	86	145	107	3222	73.4	34.5	30.7	9351	305
2	5	WI(RICL3A)-88	87	146	99	3744	75.2	37.2	32.7	10068	308
2	13	WI(RICL3A)-89	88	143	94	4071	75.8	38.7	31.0	10508	339
2	10	WI(RICL3A)-90	89	143	89	3034	72.1	38.0	30.9	7985	258
2	14	WI(RICL3A)-91	90	146	99	3015	74.3	37.2	30.4	8111	267
2	7	WI(CNN3A)	91	148	102	3053	70.2	34.4	36.6	8867	242
2	3	WI(CNN6A)	92	147	104	3011	73.9	41.1	30.5	7328	240
2	16	WI	93	144	97	4532	74.4	38.1	30.0	11894	396
2	18	CNN	94	147	107	3499	72.6	34.3	32.7	10509	321
2	1	CNN(WI3A)	95	148	94	4417	74.3	35.4	31.6	12495	395
2	8	CNN(WI6A)	96	146	107	3147	74.7	36.9	35.6	8525	239
2	7	Pronghorn	97	147	99	4303	76.1	39.7	36.3	10832	298
2	1	Jagger	98	142	91	4517	77.1	40.0	37.7	11291	300
2	15	Overland	99	147	97	5221	74.4	36.0	38.1	14509	381
2	19	Goodstreak	100	146	94	3926	74.9	36.5	35.4	10749	304
3	10	WI(RICL3A)-1	1	146	102	4505	76.4	39.3	29.2	11480	393
3	5	WI(RICL3A)-2	2	145	104	3354	74.8	38.0	32.5	8833	272
3	7	WI(RICL3A)-3	3	145	97	3994	75.1	38.9	29.7	10262	346

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	9	WI(RICL3A)-4	4	145	99	3975	74.7	37.2	29.8	10691	359
3	15	WI(RICL3A)-5	5	144	107	3534	74.7	36.8	31.5	9614	305
3	1	WI(RICL3A)-6	6	144	109	4281	74.0	37.0	32.2	11563	359
3	19	WI(RICL3A)-7	7	145	102	3472	75.8	37.4	29.1	9279	319
3	15	WI(RICL3A)-8	8	145	99	3688	76.0	35.4	31.6	10416	330
3	18	WI(RICL3A)-9	9	145	102	3369	74.6	39.3	35.7	8566	240
3	6	WI(RICL3A)-10	10	143	94	3374	75.2	38.5	33.3	8770	263
3	11	WI(RICL3A)-11	11	144	102	4236	76.5	40.5	31.3	10466	334
3	2	WI(RICL3A)-12	12	145	94	3185	75.8	37.2	29.9	8565	286
3	12	WI(RICL3A)-13	13	144	99	4052	76.0	38.8	33.2	10452	315
3	15	WI(RICL3A)-14	14	145	99	3197	74.7	37.1	32.0	8611	269
3	8	WI(RICL3A)-15	15	145	94	3502	74.7	38.8	33.1	9035	273
3	4	WI(RICL3A)-16	16	145	99	2778	74.7	35.8	33.5	7769	232
3	11	WI(RICL3A)-17	17	145	104	3421	75.6	38.4	30.1	8901	296
3	2	WI(RICL3A)-18	18	146	104	3337	73.9	37.3	30.4	8953	295
3	5	WI(RICL3A)-19	19	145	97	2963	74.7	37.8	31.0	7845	253
3	6	WI(RICL3A)-20	20	145	91	3148	75.5	40.2	28.9	7837	271
3	12	WI(RICL3A)-21	21	147	102	3510	72.7	38.6	33.8	9084	269
3	17	WI(RICL3A)-22	22	142	102	3226	75.3	37.8	35.0	8540	244
3	16	WI(RICL3A)-23	23	142	94	3602	75.7	38.2	31.5	9440	300
3	1	WI(RICL3A)-25	24	144	102	4375	75.1	40.6	32.1	10787	336
3	5	WI(RICL3A)-26	25	146	109	2974	74.7	39.7	27.6	7495	272
3	1	WI(RICL3A)-27	26	146	107	4237	73.8	38.2	30.6	11101	363
3	20	WI(RICL3A)-28	27	142	97	2775	75.6	37.6	32.3	7389	229
3	4	WI(RICL3A)-29	28	143	97	4359	74.4	38.2	31.3	11399	364
3	8	WI(RICL3A)-30	29	144	99	3917	75.5	38.3	30.3	10223	337
3	3	WI(RICL3A)-31	30	146	99	3946	74.3	33.1	31.3	11909	380
3	16	WI(RICL3A)-32	31	145	109	3233	74.6	36.9	29.9	8755	293
3	10	WI(RICL3A)-33	32	144	99	3944	76.0	40.3	28.1	9791	348
3	8	WI(RICL3A)-34	33	146	102	3498	73.4	36.0	33.1	9722	294
3	6	WI(RICL3A)-35	34	146	107	2388	72.7	37.2	30.8	6413	208
3	14	WI(RICL3A)-36	35	145	102	3139	74.3	37.5	29.9	8366	280
3	13	WI(RICL3A)-37	36	145	99	3283	73.5	40.5	29.5	8111	275
3	14	WI(RICL3A)-38	37	145	102	3326	74.6	38.3	35.5	8682	245
3	15	WI(RICL3A)-39	38	145	99	3832	75.5	41.0	35.2	9354	266
3	3	WI(RICL3A)-40	39	147	97	3014	73.0	33.1	31.4	9117	290
3	17	WI(RICL3A)-41	40	145	102	3455	75.8	40.4	34.6	8558	247
3	3	WI(RICL3A)-42	41	146	102	2530	73.3	36.1	30.5	7001	230
3	9	WI(RICL3A)-43	42	145	107	3187	74.7	35.5	28.4	8979	316
3	12	WI(RICL3A)-44	43	146	102	3414	73.3	36.1	32.8	9457	288
3	6	WI(RICL3A)-45	44	145	89	3024	74.0	36.6	33.2	8263	249
3	7	WI(RICL3A)-46	45	145	102	3179	74.6	39.4	32.7	8064	247
3	10	WI(RICL3A)-47	46	144	102	3810	75.3	38.5	31.4	9886	315
3	2	WI(RICL3A)-48	47	144	104	4584	74.2	40.2	35.6	11396	320
3	3	WI(RICL3A)-49	48	145	99	3798	73.6	39.5	33.9	9622	284
3	18	WI(RICL3A)-50	49	145	91	3269	75.6	37.2	30.6	8789	287
3	19	WI(RICL3A)-51	50	145	97	3676	75.5	36.0	31.3	10199	326
3	1	WI(RICL3A)-52	51	145	102	4076	75.7	41.0	35.1	9949	283
3	19	WI(RICL3A)-53	52	146	104	2432	73.3	33.4	29.2	7291	250
3	13	WI(RICL3A)-54	53	145	99	3305	74.3	36.4	31.5	9091	289
3	11	WI(RICL3A)-55	54	146	102	4094	76.1	40.0	32.3	10235	317
3	9	WI(RICL3A)-56	55	146	97	2918	74.8	38.4	30.3	7595	251

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	12	WI(RICL3A)-57	56	142	99	3975	75.8	39.2	27.3	10151	372
3	10	WI(RICL3A)-58	57	145	102	3956	75.7	36.5	37.2	10844	292
3	4	WI(RICL3A)-59	58	146	91	3441	72.2	35.6	34.5	9675	280
3	16	WI(RICL3A)-60	59	142	91	3150	74.9	39.7	31.0	7940	256
3	13	WI(RICL3A)-61	60	142	94	3710	75.3	40.8	31.4	9087	289
3	14	WI(RICL3A)-62	61	145	102	3886	75.1	37.0	33.1	10508	317
3	13	WI(RICL3A)-63	62	145	91	2895	74.4	37.0	31.8	7823	246
3	7	WI(RICL3A)-64	63	142	91	3468	75.3	41.1	30.4	8434	277
3	2	WI(RICL3A)-65	64	145	94	2856	73.3	34.8	26.0	8205	316
3	1	WI(RICL3A)-66	65	145	99	3808	75.5	37.2	27.4	10239	374
3	20	WI(RICL3A)-67	66	146	86	3381	75.5	36.6	28.2	9238	328
3	2	WI(RICL3A)-68	67	142	97	3582	75.1	39.3	32.2	9119	283
3	15	WI(RICL3A)-69	68	145	102	3064	74.2	39.2	28.1	7827	279
3	16	WI(RICL3A)-70	69	142	94	3093	75.2	38.2	29.2	8092	277
3	9	WI(RICL3A)-71	70	146	104	2833	72.5	31.2	33.6	9084	270
3	12	WI(RICL3A)-72	71	146	102	3444	74.7	38.3	29.4	9002	306
3	14	WI(RICL3A)-73	72	145	102	3028	75.1	37.7	32.9	8028	244
3	5	WI(RICL3A)-74	73	145	99	2826	75.6	37.9	26.7	7455	279
3	20	WI(RICL3A)-75	74	145	94	3672	76.4	41.0	30.5	8966	294
3	19	WI(RICL3A)-76	75	145	99	3508	76.7	40.3	28.5	8709	306
3	3	WI(RICL3A)-77	76	147	91	.	70.0	35.7	30.3	.	.
3	11	WI(RICL3A)-78	77	144	94	2672	72.5	37.9	36.3	7048	194
3	18	WI(RICL3A)-79	78	143	94	3233	73.8	39.2	34.3	8257	241
3	7	WI(RICL3A)-80	79	142	91	3303	75.8	41.4	35.0	7979	228
3	16	WI(RICL3A)-81	80	142	89	3480	76.5	39.0	29.8	8933	300
3	13	WI(RICL3A)-82	81	143	97	3154	76.5	39.9	28.7	7912	276
3	8	WI(RICL3A)-83	82	142	99	3544	67.7	37.6	29.2	9426	323
3	20	WI(RICL3A)-84	83	145	97	4164	75.2	38.8	32.9	10728	326
3	18	WI(RICL3A)-85	84	145	99	3085	74.0	38.1	34.4	8089	235
3	5	WI(RICL3A)-86	85	144	91	3021	75.2	40.7	31.7	7417	234
3	9	WI(RICL3A)-87	86	145	107	3172	73.9	36.8	29.8	8623	289
3	4	WI(RICL3A)-88	87	147	99	.	73.5	38.5	35.9	.	.
3	18	WI(RICL3A)-89	88	142	86	3321	76.4	37.9	30.8	8772	285
3	17	WI(RICL3A)-90	89	142	94	2788	75.3	42.5	29.6	6565	222
3	14	WI(RICL3A)-91	90	145	99	3068	74.4	38.1	30.2	8049	267
3	7	WI(CNN3A)	91	148	97	3474	74.4	37.1	30.6	9358	306
3	4	WI(CNN6A)	92	148	94	2718	72.0	31.6	30.5	8590	282
3	17	WI	93	145	99	3800	75.7	39.7	33.3	9571	287
3	8	CNN	94	148	107	3383	71.8	31.0	37.7	10901	289
3	19	CNN(WI3A)	95	147	97	4102	75.6	32.2	33.5	12736	380
3	20	CNN(WI6A)	96	147	102	3724	76.6	40.2	33.2	9267	279
3	10	Pronghorn	97	145	94	4978	76.7	34.8	32.8	14298	436
3	11	Jagger	98	142	91	4060	76.2	33.7	43.9	12033	274
3	17	Overland	99	147	97	4754	75.3	35.0	33.9	13577	401
3	6	Goodstreak	100	147	99	4306	75.6	32.3	35.5	13326	375

Appendix 10. Field dataset for anthesis date (AD), plant height (PHT), grain yield (GYLD), grain volume weight (GVW), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), and spikes per square meter (SPSM), evaluated in WI(RICLs-3A) mapping population at North Platte, NE during 2009 cropping season.

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	1	WI(RICL3A)-1	1	148	117	3638	72.7	35.4	25.1	10270	409
1	1	WI(RICL3A)-2	1	.	91	3627	77.5	39.3	24.4	9218	378
1	1	WI(RICL3A)-3	2	148	119	3190	72.5	31.7	27.0	10062	373
1	1	WI(RICL3A)-4	2	.	91	3280	76.5	36.2	24.7	9071	367
1	1	WI(RICL3A)-5	3	148	117	3566	74.0	36.0	25.2	9895	393
1	1	WI(RICL3A)-6	4	148	117	3061	74.2	32.2	26.1	9501	364
1	1	WI(RICL3A)-7	5	149	127	3181	72.5	31.0	28.0	10260	366
1	2	WI(RICL3A)-8	6	148	124	3258	72.4	29.0	23.1	11251	487
1	2	WI(RICL3A)-9	7	147	117	3485	73.8	33.5	22.8	10414	457
1	2	WI(RICL3A)-10	8	147	117	3319	74.6	33.9	25.9	9781	378
1	2	WI(RICL3A)-11	9	149	127	3331	74.4	32.9	22.2	10116	456
1	2	WI(RICL3A)-12	10	146	117	3292	74.3	33.1	23.9	9947	416
1	3	WI(RICL3A)-13	11	147	119	3736	74.0	32.5	21.9	11507	525
1	3	WI(RICL3A)-14	12	147	112	3627	74.8	35.8	22.2	10142	457
1	3	WI(RICL3A)-15	13	147	109	3024	73.6	34.6	24.1	8748	363
1	3	WI(RICL3A)-16	14	148	119	3426	74.2	33.8	25.6	10128	396
1	3	WI(RICL3A)-17	15	145	112	3293	74.7	35.8	22.8	9189	403
1	4	WI(RICL3A)-18	16	147	122	3188	73.4	33.0	24.5	9666	395
1	4	WI(RICL3A)-19	17	147	114	3076	75.1	34.1	23.5	9026	384
1	4	WI(RICL3A)-20	18	149	122	3182	74.4	36.6	22.4	8693	388
1	4	WI(RICL3A)-21	19	147	117	3273	74.9	31.5	24.2	10380	429
1	4	WI(RICL3A)-22	20	146	109	3372	74.7	35.3	20.0	9553	478
1	5	WI(RICL3A)-23	21	148	119	3415	74.0	34.2	22.1	9983	452
1	5	WI(RICL3A)-25	22	145	117	2946	74.9	34.3	22.6	8601	381
1	5	WI(RICL3A)-26	23	146	117	2973	.	34.9	26.1	8517	326
1	5	WI(RICL3A)-27	24	147	122	3251	75.7	33.2	21.4	9786	457
1	5	WI(RICL3A)-28	25	148	117	2760	75.2	35.1	21.0	7865	375
1	6	WI(RICL3A)-29	26	147	114	3092	73.0	32.8	23.0	9420	410
1	6	WI(RICL3A)-30	27	146	112	2633	73.8	34.1	25.1	7730	308
1	6	WI(RICL3A)-31	28	146	117	4022	74.6	34.5	22.4	11670	521
1	6	WI(RICL3A)-32	29	147	112	2954	74.6	33.1	24.9	8917	358
1	6	WI(RICL3A)-33	30	148	112	3326	75.1	32.5	22.7	10245	451
1	7	WI(RICL3A)-34	31	148	119	4063	73.9	.	.	.	.
1	7	WI(RICL3A)-35	32	147	112	3752	75.7	36.2	20.3	10363	510
1	7	WI(RICL3A)-36	33	148	122	3583	73.8	34.4	20.5	10418	508
1	7	WI(RICL3A)-37	34	148	119	3625	73.9	33.9	24.6	10693	435
1	7	WI(RICL3A)-38	35	148	119	3368	74.0	32.1	21.7	10484	483
1	8	WI(RICL3A)-39	36	147	117	3760	73.6	33.5	24.3	11237	462
1	8	WI(RICL3A)-40	37	147	119	3302	74.6	34.7	24.6	9523	387
1	8	WI(RICL3A)-41	38	147	109	3464	75.3	37.1	22.8	9346	410
1	8	WI(RICL3A)-42	39	147	114	2779	74.2	26.8	25.5	10377	407
1	8	WI(RICL3A)-43	40	147	117	4029	74.0	34.5	23.2	11683	504
1	9	WI(RICL3A)-44	41	147	114	4021	75.1	32.1	19.4	12522	645
1	9	WI(RICL3A)-45	42	148	124	4321	73.9	34.0	23.1	12715	550
1	9	WI(RICL3A)-46	43	148	124	3863	72.0	34.6	21.1	11167	529
1	9	WI(RICL3A)-47	44	147	114	4071	74.2	33.1	23.6	12286	521
1	9	WI(RICL3A)-48	45	148	122	3683	73.9	36.4	24.2	10116	418

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	10	WI(RICL3A)-49	46	148	119	4240	75.2	31.5	23.6	13468	571
1	10	WI(RICL3A)-50	47	147	112	3986	73.5	34.3	21.4	11639	544
1	10	WI(RICL3A)-51	48	147	122	4390	73.3	34.8	24.8	12616	509
1	10	WI(RICL3A)-52	49	148	117	4136	74.2	32.7	18.7	12639	676
1	10	WI(RICL3A)-53	50	147	117	4559	74.6	34.2	27.5	13324	485
1	11	WI(RICL3A)-54	51	147	119	4409	74.8	31.4	25.8	14062	545
1	11	WI(RICL3A)-55	52	149	130	3767	73.0	35.5	23.0	10606	461
1	11	WI(RICL3A)-56	53	148	122	3983	73.1	30.8	26.7	12921	484
1	11	WI(RICL3A)-57	54	149	122	4486	76.2	32.7	23.4	13723	586
1	11	WI(RICL3A)-58	55	149	119	4098	73.0	33.3	24.6	12294	500
1	12	WI(RICL3A)-59	56	146	112	4117	74.8	36.1	25.4	11417	449
1	12	WI(RICL3A)-60	57	149	124	3610	73.5	27.2	26.2	13283	507
1	12	WI(RICL3A)-61	58	148	114	4102	74.7	33.8	23.1	12132	525
1	12	WI(RICL3A)-62	59	147	114	4025	74.3	35.4	24.4	11380	466
1	12	WI(RICL3A)-63	60	147	119	3667	74.0	32.6	28.4	11236	396
1	13	WI(RICL3A)-64	61	148	119	3725	73.8	30.7	23.3	12123	520
1	13	WI(RICL3A)-65	62	148	124	3797	73.4	30.7	26.5	12378	467
1	13	WI(RICL3A)-66	63	146	109	3863	74.4	35.4	26.0	10916	420
1	13	WI(RICL3A)-67	64	148	119	3551	74.3	33.4	24.2	10649	440
1	13	WI(RICL3A)-68	65	148	114	4132	74.3	31.8	25.1	13012	518
1	14	WI(RICL3A)-69	66	146	114	3990	74.8	29.6	23.4	13491	577
1	14	WI(RICL3A)-70	67	146	114	3760	74.3	30.1	20.9	12514	599
1	14	WI(RICL3A)-71	68	148	122	3453	73.1	35.2	21.9	9808	448
1	14	WI(RICL3A)-72	69	146	114	3626	74.8	32.6	21.1	11137	528
1	14	WI(RICL3A)-73	70	147	127	3367	73.9	34.9	23.8	9655	406
1	15	WI(RICL3A)-74	71	147	124	3506	74.9	35.6	22.6	9844	436
1	15	WI(RICL3A)-75	72	147	124	3419	74.4	35.6	25.9	9606	371
1	15	WI(RICL3A)-76	73	147	122	3879	74.7	32.8	23.1	11820	512
1	15	WI(RICL3A)-77	74	147	119	3947	75.7	35.3	22.1	11182	506
1	15	WI(RICL3A)-78	75	148	122	3567	75.2	33.3	25.9	10717	414
1	16	WI(RICL3A)-79	76	148	114	3494	74.8	30.4	23.9	11485	481
1	16	WI(RICL3A)-80	77	148	112	2366	71.7	33.3	25.6	7108	278
1	16	WI(RICL3A)-81	78	146	119	3324	74.6	35.1	23.7	9480	400
1	16	WI(RICL3A)-82	79	146	112	3684	76.4	34.7	23.4	10617	454
1	16	WI(RICL3A)-83	80	146	107	3246	74.6	35.7	22.3	9081	407
1	17	WI(RICL3A)-84	81	146	109	3180	75.5	35.5	22.2	8969	404
1	17	WI(RICL3A)-85	82	145	114	2956	74.9	36.7	23.7	8054	340
1	17	WI(RICL3A)-86	83	147	119	3185	74.7	30.7	21.7	10378	478
1	17	WI(RICL3A)-87	84	147	117	3624	75.6	33.8	22.6	10721	474
1	17	WI(RICL3A)-88	85	146	112	3114	76.4	30.4	23.2	10247	442
1	18	WI(RICL3A)-89	86	147	124	3041	73.5	34.7	24.4	8772	360
1	18	WI(RICL3A)-90	87	148	117	2926	74.3	34.6	22.2	8457	381
1	18	WI(RICL3A)-91	88	145	112	2594	75.5	30.2	21.5	8592	400
1	18	WI(CNN3A)	89	146	114	3025	76.4	39.6	22.0	7640	347
1	18	WI(CNN6A)	90	147	117	3066	75.8	32.9	23.2	9311	401
1	19	WI	91	148	122	3058	75.3	37.2	21.1	8230	390
1	19	CNN	92	148	112	2659	75.3	34.5	19.7	7715	392
1	19	CNN(WI3A)	93	146	112	3186	75.7	35.0	22.3	9098	408
1	19	CNN(WI6A)	94	150	119	3519	76.4	33.8	23.6	10407	441
1	19	Pronghorn	95	149	114	3773	77.5	34.2	22.5	11025	490
1	20	Jagger	96	148	119	3321	76.2	37.2	20.5	8936	436
1	20	Overland	97	147	112	4346	77.0	32.7	26.0	13310	512

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	20	Goodstreak	98	146	86	5483	75.6	33.3	30.3	16449	543
1	20	WI(RICL3A)-1	99	148	91	5272	75.6	31.8	28.2	16593	588
1	20	WI(RICL3A)-2	100	149	112	4854	77.3	31.7	30.0	15311	510
2	15	WI(RICL3A)-3	1	149	119	3805	74.3	33.3	23.0	11425	497
2	2	WI(RICL3A)-4	2	147	122	3107	75.3	33.4	24.4	9291	381
2	1	WI(RICL3A)-5	3	147	117	3450	75.3	35.0	23.0	9845	428
2	7	WI(RICL3A)-6	4	147	122	4162	75.2	30.7	21.6	13560	628
2	10	WI(RICL3A)-7	5	147	122	3302	74.6	30.9	22.1	10686	484
2	18	WI(RICL3A)-8	6	147	117	3482	75.3	34.1	25.9	10202	394
2	2	WI(RICL3A)-9	7	147	119	3486	74.2	35.7	26.7	9777	366
2	14	WI(RICL3A)-10	8	148	117	3539	74.4	29.1	20.9	12167	582
2	4	WI(RICL3A)-11	9	149	122	3288	72.4	28.6	21.5	11496	535
2	16	WI(RICL3A)-12	10	147	117	3334	73.8	29.7	20.4	11224	550
2	1	WI(RICL3A)-13	11	147	117	3569	74.9	31.6	21.6	11286	522
2	4	WI(RICL3A)-14	12	148	117	3473	73.6	32.8	21.0	10585	504
2	20	WI(RICL3A)-15	13	147	117	3279	74.9	31.8	20.4	10323	506
2	17	WI(RICL3A)-16	14	148	119	3532	73.3	30.9	23.7	11420	482
2	19	WI(RICL3A)-17	15	146	112	3289	75.3	31.1	25.7	10579	412
2	11	WI(RICL3A)-18	16	147	119	2842	74.7	31.3	24.9	9083	365
2	8	WI(RICL3A)-19	17	147	117	3735	75.8	30.3	29.9	12340	413
2	18	WI(RICL3A)-20	18	149	124	3669	74.6	30.5	21.9	12045	550
2	13	WI(RICL3A)-21	19	147	117	3271	74.4	32.9	26.0	9947	383
2	1	WI(RICL3A)-22	20	145	112	3427	75.5	33.9	18.3	10115	553
2	18	WI(RICL3A)-23	21	148	127	3499	74.8	35.7	21.3	9793	460
2	6	WI(RICL3A)-25	22	146	122	3930	74.0	29.4	23.7	13382	565
2	19	WI(RICL3A)-26	23	146	117	3426	74.3	31.8	25.2	10764	427
2	12	WI(RICL3A)-27	24	147	124	3108	73.3	31.4	27.2	9886	363
2	5	WI(RICL3A)-28	25	149	124	3304	73.1	33.0	26.2	10020	382
2	4	WI(RICL3A)-29	26	148	122	3756	71.8	34.1	27.7	11022	398
2	10	WI(RICL3A)-30	27	146	109	2916	75.6	32.5	22.3	8969	402
2	6	WI(RICL3A)-31	28	146	119	4130	74.6	30.5	24.3	13563	558
2	11	WI(RICL3A)-32	29	147	117	3223	74.7	33.2	24.2	9702	401
2	17	WI(RICL3A)-33	30	149	114	3639	73.9	28.0	23.6	13011	551
2	11	WI(RICL3A)-34	31	148	122	3514	73.9	34.1	27.7	10300	372
2	3	WI(RICL3A)-35	32	148	119	3605	73.9	34.9	22.1	10319	467
2	2	WI(RICL3A)-36	33	148	122	3536	74.6	31.0	24.1	11407	473
2	9	WI(RICL3A)-37	34	149	124	2892	72.4	27.2	24.3	10633	438
2	19	WI(RICL3A)-38	35	148	122	3033	72.7	31.4	25.3	9651	381
2	13	WI(RICL3A)-39	36	147	119	3317	74.2	32.0	22.1	10369	469
2	19	WI(RICL3A)-40	37	147	124	2943	72.5	29.3	22.6	10047	445
2	10	WI(RICL3A)-41	38	147	112	3040	75.2	32.4	22.8	9391	412
2	7	WI(RICL3A)-42	39	148	119	3013	74.7	27.6	24.5	10902	445
2	14	WI(RICL3A)-43	40	147	122	3600	74.6	31.3	22.0	11494	522
2	10	WI(RICL3A)-44	41	147	112	3098	74.6	29.9	24.3	10354	426
2	18	WI(RICL3A)-45	42	148	119	3286	74.0	27.9	20.8	11763	566
2	5	WI(RICL3A)-46	43	149	119	3374	72.4	31.1	24.7	10866	440
2	3	WI(RICL3A)-47	44	148	117	3717	74.9	30.8	22.1	12062	546
2	20	WI(RICL3A)-48	45	148	119	3489	74.9	31.9	24.9	10941	439
2	20	WI(RICL3A)-49	46	147	122	3252	74.4	33.4	23.4	9745	416
2	16	WI(RICL3A)-50	47	147	117	3814	75.1	32.7	22.5	11675	519
2	13	WI(RICL3A)-51	48	148	122	3235	74.0	32.1	24.8	10078	406
2	6	WI(RICL3A)-52	49	147	117	3484	74.4	32.1	23.5	10859	462

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
2	15	WI(RICL3A)-53	50	147	122	4024	73.5	29.5	25.8	13642	529
2	20	WI(RICL3A)-54	51	148	119	3632	75.2	32.6	25.9	11132	430
2	8	WI(RICL3A)-55	52	151	124	2778	73.5	31.3	25.6	8878	347
2	12	WI(RICL3A)-56	53	147	117	3195	73.5	28.2	27.4	11326	413
2	14	WI(RICL3A)-57	54	147	117	3634	74.4	30.0	24.4	12129	497
2	2	WI(RICL3A)-58	55	148	124	3793	77.4	32.5	23.3	11658	500
2	3	WI(RICL3A)-59	56	146	117	3354	74.7	31.6	21.4	10619	496
2	14	WI(RICL3A)-60	57	148	124	3287	72.6	26.2	25.4	12554	494
2	1	WI(RICL3A)-61	58	147	114	3035	74.9	35.8	26.8	8481	316
2	9	WI(RICL3A)-62	59	147	122	3602	74.8	32.0	24.8	11263	454
2	6	WI(RICL3A)-63	60	146	119	4093	74.2	28.9	25.0	14172	567
2	7	WI(RICL3A)-64	61	147	119	3548	74.9	28.7	24.8	12375	499
2	4	WI(RICL3A)-65	62	148	119	3213	72.1	30.7	26.8	10474	391
2	20	WI(RICL3A)-66	63	146	114	3539	76.4	31.3	24.0	11294	471
2	5	WI(RICL3A)-67	64	148	117	3574	73.6	30.0	26.5	11928	450
2	9	WI(RICL3A)-68	65	147	109	3396	74.2	30.7	24.9	11067	444
2	7	WI(RICL3A)-69	66	146	109	3912	74.9	30.9	20.3	12667	624
2	1	WI(RICL3A)-70	67	145	114	3407	75.1	34.4	23.1	9912	429
2	12	WI(RICL3A)-71	68	147	122	2789	73.8	29.0	20.7	9606	464
2	11	WI(RICL3A)-72	69	146	114	3159	74.0	30.0	19.1	10530	551
2	16	WI(RICL3A)-73	70	148	122	3351	70.8	31.4	27.6	10678	387
2	17	WI(RICL3A)-74	71	148	124	3236	72.7	33.8	26.3	9573	364
2	2	WI(RICL3A)-75	72	147	124	3855	74.3	34.6	27.5	11136	405
2	13	WI(RICL3A)-76	73	147	114	3544	74.2	32.8	23.5	10803	460
2	5	WI(RICL3A)-77	74	148	117	4081	74.6	33.5	23.7	12166	513
2	16	WI(RICL3A)-78	75	148	122	3718	74.3	27.3	22.2	13599	613
2	7	WI(RICL3A)-79	76	148	117	3738	75.2	30.9	23.5	12083	514
2	6	WI(RICL3A)-80	77	147	117	3348	72.4	32.5	20.2	10309	510
2	8	WI(RICL3A)-81	78	146	117	3416	74.6	32.2	21.8	10607	487
2	3	WI(RICL3A)-82	79	147	117	3489	75.3	35.2	24.0	9911	413
2	17	WI(RICL3A)-83	80	147	112	2710	73.5	28.3	24.3	9571	394
2	8	WI(RICL3A)-84	81	146	109	3326	75.7	39.0	21.2	8536	403
2	19	WI(RICL3A)-85	82	146	117	3426	74.7	27.8	22.5	12312	547
2	9	WI(RICL3A)-86	83	147	112	3716	74.4	31.6	25.3	11752	465
2	10	WI(RICL3A)-87	84	148	112	2760	75.6	32.4	22.8	8516	374
2	16	WI(RICL3A)-88	85	147	117	3929	72.5	28.1	23.0	13968	607
2	3	WI(RICL3A)-89	86	148	130	3256	74.3	35.1	21.4	9289	434
2	12	WI(RICL3A)-90	87	147	112	2907	72.0	28.9	24.7	10056	407
2	15	WI(RICL3A)-91	88	146	114	2851	74.3	30.5	20.7	9339	451
2	13	WI(CNN3A)	89	146	117	2982	74.0	29.9	23.1	9969	432
2	4	WI(CNN6A)	90	148	122	3536	74.3	32.2	22.0	10971	499
2	18	WI	91	149	124	2860	72.7	31.0	22.7	9234	407
2	9	CNN	92	149	117	3206	74.8	33.3	23.3	9637	414
2	17	CNN(WI3A)	93	145	114	3379	72.9	31.0	25.2	10917	433
2	12	CNN(WI6A)	94	148	117	3393	76.0	28.1	23.4	13485	576
2	15	Pronghorn	95	151	117	4205	74.8	31.2	27.2	13472	495
2	11	Jagger	96	148	122	3498	75.8	31.6	21.1	11065	524
2	14	Overland	97	148	114	4292	75.3	28.1	27.1	15265	563
2	8	Goodstreak	98	147	86	5171	76.4	45.4	23.8	11394	479
2	15	WI(RICL3A)-1	99	151	94	6004	74.7	27.6	32.5	21728	669
2	5	WI(RICL3A)-2	100	150	119	4888	74.9	28.8	29.4	16986	578
3	19	WI(RICL3A)-3	1	148	122	4242	76.0	34.6	22.4	12261	547

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	3	WI(RICL3A)-4	2	147	119	3413	73.6	32.7	27.7	10424	376
3	5	WI(RICL3A)-5	3	147	117	3575	74.8	31.6	23.0	11310	492
3	6	WI(RICL3A)-6	4	147	117	4059	76.0	31.5	23.6	12894	546
3	9	WI(RICL3A)-7	5	148	124	3300	71.1	32.1	22.4	10266	458
3	19	WI(RICL3A)-8	6	147	122	3866	76.1	33.9	22.4	11408	509
3	7	WI(RICL3A)-9	7	147	124	3921	74.6	29.8	21.0	13174	627
3	13	WI(RICL3A)-10	8	147	112	3322	74.7	30.7	20.1	10820	538
3	20	WI(RICL3A)-11	9	150	122	2678	71.2	29.6	20.2	9062	449
3	1	WI(RICL3A)-12	10	145	119	3725	75.7	30.8	21.1	12093	573
3	7	WI(RICL3A)-13	11	148	122	3617	73.8	26.9	24.7	13434	544
3	4	WI(RICL3A)-14	12	147	114	3341	75.7	30.6	22.3	10926	490
3	3	WI(RICL3A)-15	13	147	117	3066	74.9	28.9	24.9	10604	426
3	14	WI(RICL3A)-16	14	148	122	3430	73.5	33.1	22.7	10355	456
3	6	WI(RICL3A)-17	15	146	117	3866	74.7	24.8	27.4	15577	568
3	8	WI(RICL3A)-18	16	148	119	3401	72.6	29.2	21.6	11662	540
3	6	WI(RICL3A)-19	17	147	114	3281	73.6	31.6	25.6	10394	406
3	9	WI(RICL3A)-20	18	149	119	3536	74.2	31.3	23.0	11311	492
3	16	WI(RICL3A)-21	19	147	114	3435	75.1	36.3	20.6	9460	459
3	12	WI(RICL3A)-22	20	145	114	3389	74.8	29.5	21.9	11488	525
3	15	WI(RICL3A)-23	21	148	122	3232	75.1	35.8	19.7	9019	458
3	20	WI(RICL3A)-25	22	146	114	3296	74.3	34.7	26.2	9509	363
3	8	WI(RICL3A)-26	23	146	119	3258	72.9	29.5	27.9	11031	395
3	10	WI(RICL3A)-27	24	147	122	4089	75.7	37.8	26.8	10827	404
3	17	WI(RICL3A)-28	25	147	122	2989	74.2	36.1	22.0	8270	376
3	17	WI(RICL3A)-29	26	147	114	3141	73.3	30.8	20.6	10188	495
3	18	WI(RICL3A)-30	27	146	117	2998	75.2	30.1	21.6	9963	461
3	19	WI(RICL3A)-31	28	147	117	3748	73.0	28.5	21.6	13165	609
3	2	WI(RICL3A)-32	29	147	117	3492	75.3	33.6	21.9	10391	474
3	9	WI(RICL3A)-33	30	148	117	3184	73.4	28.8	23.7	11048	466
3	10	WI(RICL3A)-34	31	147	124	3772	75.8	32.7	23.5	11527	491
3	14	WI(RICL3A)-35	32	147	119	3271	76.2	35.4	21.7	9229	425
3	16	WI(RICL3A)-36	33	147	122	2726	72.6	33.3	19.7	8186	416
3	20	WI(RICL3A)-37	34	150	119	2732	72.1	29.0	25.4	9416	371
3	11	WI(RICL3A)-38	35	148	119	3333	74.4	29.0	27.5	11485	418
3	14	WI(RICL3A)-39	36	148	122	3324	74.3	30.1	20.5	11061	540
3	4	WI(RICL3A)-40	37	147	119	2936	74.0	31.2	22.7	9427	415
3	13	WI(RICL3A)-41	38	146	117	2554	74.9	36.5	19.3	7001	363
3	20	WI(RICL3A)-42	39	148	112	2678	70.9	33.0	22.3	8126	364
3	2	WI(RICL3A)-43	40	147	117	3302	74.8	31.9	21.3	10344	486
3	1	WI(RICL3A)-44	41	147	112	3316	74.6	30.5	22.1	10872	492
3	7	WI(RICL3A)-45	42	148	124	3206	73.4	28.1	20.9	11396	545
3	14	WI(RICL3A)-46	43	148	124	2963	73.3	34.0	20.2	8711	431
3	5	WI(RICL3A)-47	44	147	117	3243	74.6	29.7	23.6	10934	463
3	16	WI(RICL3A)-48	45	148	114	3501	73.3	36.9	26.5	9497	358
3	9	WI(RICL3A)-49	46	148	119	3274	72.5	31.6	20.2	10365	513
3	18	WI(RICL3A)-50	47	147	112	3457	74.4	32.0	19.5	10803	554
3	3	WI(RICL3A)-51	48	147	117	3125	72.9	29.3	25.9	10649	411
3	13	WI(RICL3A)-52	49	147	109	3668	74.4	34.2	21.0	10729	511
3	7	WI(RICL3A)-53	50	147	122	3944	75.6	31.2	21.6	12640	585
3	12	WI(RICL3A)-54	51	147	122	3085	74.2	34.0	20.2	9083	450
3	5	WI(RICL3A)-55	52	150	124	2979	72.2	31.0	25.2	9625	382
3	14	WI(RICL3A)-56	53	148	114	2972	74.4	32.8	22.5	9061	403

Rep	Iblock	Name	Entry	AD	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
3	10	WI(RICL3A)-57	54	148	117	3553	74.2	30.7	24.2	11573	478
3	8	WI(RICL3A)-58	55	149	117	3541	73.0	29.8	22.3	11874	532
3	12	WI(RICL3A)-59	56	145	117	3380	75.2	37.0	18.2	9140	502
3	17	WI(RICL3A)-60	57	147	112	2941	73.9	32.4	19.1	9090	476
3	1	WI(RICL3A)-61	58	147	117	3193	74.9	35.3	22.1	9034	409
3	9	WI(RICL3A)-62	59	148	114	3426	75.1	32.2	23.9	10633	445
3	15	WI(RICL3A)-63	60	146	117	3964	75.3	33.9	17.9	11708	654
3	10	WI(RICL3A)-64	61	147	122	3902	74.7	32.5	18.6	11995	645
3	15	WI(RICL3A)-65	62	147	119	3764	74.8	35.6	17.7	10576	597
3	19	WI(RICL3A)-66	63	146	112	3657	77.0	32.2	19.9	11370	571
3	2	WI(RICL3A)-67	64	147	117	3486	74.8	33.5	23.5	10421	443
3	13	WI(RICL3A)-68	65	147	114	3341	74.2	31.3	22.5	10678	475
3	11	WI(RICL3A)-69	66	145	112	3827	74.9	36.3	19.9	10549	530
3	18	WI(RICL3A)-70	67	145	109	3112	74.6	33.3	20.2	9355	463
3	4	WI(RICL3A)-71	68	148	124	3333	74.0	29.4	23.5	11336	482
3	13	WI(RICL3A)-72	69	146	114	3255	74.9	35.3	18.7	9222	493
3	17	WI(RICL3A)-73	70	147	124	3255	72.5	33.3	21.1	9782	464
3	5	WI(RICL3A)-74	71	147	124	3321	74.0	32.1	22.9	10334	451
3	6	WI(RICL3A)-75	72	147	122	4092	74.2	31.6	22.5	12949	576
3	10	WI(RICL3A)-76	73	147	119	3888	75.7	34.5	19.1	11269	590
3	4	WI(RICL3A)-77	74	147	114	3683	75.8	32.5	22.0	11349	516
3	2	WI(RICL3A)-78	75	147	114	3332	75.6	34.1	25.2	9776	388
3	8	WI(RICL3A)-79	76	148	119	2701	73.3	34.1	21.6	7928	367
3	11	WI(RICL3A)-80	77	147	114	2864	71.7	32.7	23.2	8754	377
3	3	WI(RICL3A)-81	78	146	114	2886	74.4	35.0	23.5	8250	351
3	4	WI(RICL3A)-82	79	146	112	3436	75.3	31.4	21.2	10937	516
3	16	WI(RICL3A)-83	80	146	107	2957	74.0	35.6	19.5	8308	426
3	7	WI(RICL3A)-84	81	146	112	3722	74.2	29.2	24.7	12749	516
3	5	WI(RICL3A)-85	82	146	114	3195	75.2	26.5	26.2	12062	460
3	19	WI(RICL3A)-86	83	147	122	4087	73.8	34.5	19.4	11834	610
3	12	WI(RICL3A)-87	84	147	117	3202	74.3	32.9	19.3	9747	505
3	15	WI(RICL3A)-88	85	145	119	3463	75.7	32.8	20.8	10563	508
3	6	WI(RICL3A)-89	86	147	130	3184	74.3	30.9	21.8	10297	472
3	2	WI(RICL3A)-90	87	147	112	3532	74.0	34.0	22.7	10399	458
3	17	WI(RICL3A)-91	88	145	109	2944	74.3	35.1	19.8	8388	424
3	8	WI(CNN3A)	89	147	122	2903	72.9	30.9	21.3	9397	441
3	11	WI(CNN6A)	90	147	114	3875	75.5	34.8	17.4	11143	640
3	3	WI	91	148	124	2797	74.4	27.7	23.9	10113	423
3	18	CNN	92	148	117	2536	73.8	35.8	21.8	7087	325
3	12	CNN(WI3A)	93	146	114	3498	74.0	29.3	27.1	11953	441
3	16	CNN(WI6A)	94	148	118	3614	76.5	30.6	19.8	13768	695
3	1	Pronghorn	95	147	112	3848	77.3	31.1	30.3	12392	409
3	20	Jagger	96	150	119	3118	72.5	34.2	19.6	9109	465
3	18	Overland	97	148	112	3862	77.4	34.3	23.3	11263	483
3	1	Goodstreak	98	146	91	5220	76.6	32.8	29.8	15922	534
3	15	WI(RICL3A)-1	99	149	97	4742	76.2	27.7	28.9	17132	593
3	11	WI(RICL3A)-2	100	148	117	5296	75.7	30.1	28.4	17591	619

Appendix 11. Field dataset for plant height (PHT), grain yield (GYLD), grain volume weight (GVW), 1000-kernel weight (TKW), kernels per spike (KPS), kernels per square meter (KPSM), and spikes per square meter (SPSM), evaluated in WI(RICLs-3A) mapping population at Sidney, NE during 2009 cropping season.

Rep	Iblock	Name	Entry	PHT	GYLD	GVWT	TKW	KPS	KPSM	SPSM
1	1	WI(RICL3A)-1	1	91	3627	77.5	39.3	24.4	9218	378
1	1	WI(RICL3A)-2	2	91	3280	76.5	36.2	24.7	9071	367
1	1	WI(RICL3A)-3	3	91	3135	76.6	37.9	22.9	8280	362
1	1	WI(RICL3A)-4	4	97	3433	77.0	38.0	22.7	9030	398
1	1	WI(RICL3A)-5	5	102	3098	76.5	39.2	27.2	7897	290
1	2	WI(RICL3A)-6	6	94	3559	76.6	36.5	26.0	9760	375
1	2	WI(RICL3A)-7	7	91	3478	76.0	35.1	21.9	9905	452
1	2	WI(RICL3A)-8	8	94	3278	76.4	34.1	24.3	9609	395
1	2	WI(RICL3A)-9	9	97	3201	76.1	36.9	23.2	8674	374
1	2	WI(RICL3A)-10	10	97	3861	76.0	34.9	19.1	11056	579
1	3	WI(RICL3A)-11	11	91	3962	75.6	36.2	23.7	10958	462
1	3	WI(RICL3A)-12	12	99	3994	75.5	35.1	21.9	11375	519
1	3	WI(RICL3A)-13	13	104	3621	76.4	35.9	23.6	10090	428
1	3	WI(RICL3A)-14	14	104	3864	75.1	35.9	23.9	10777	451
1	3	WI(RICL3A)-15	15	97	4261	76.1	36.5	26.0	11675	449
1	4	WI(RICL3A)-16	16	102	4046	76.9	38.2	24.5	10590	432
1	4	WI(RICL3A)-17	17	97	3762	76.0	35.9	20.0	10493	525
1	4	WI(RICL3A)-18	18	104	3899	77.3	38.3	25.0	10186	407
1	4	WI(RICL3A)-19	19	99	3842	75.1	37.1	23.8	10344	435
1	4	WI(RICL3A)-20	20	74	2881	75.8	34.0	22.3	8464	380
1	5	WI(RICL3A)-21	21	97	4376	76.6	36.6	20.1	11968	595
1	5	WI(RICL3A)-22	22	99	3843	75.2	34.1	24.8	11279	455
1	5	WI(RICL3A)-23	23	99	3673	76.2	33.9	22.1	10852	491
1	5	WI(RICL3A)-25	24	94	3430	75.1	40.3	21.5	8516	396
1	5	WI(RICL3A)-26	25	99	3545	77.1	36.7	20.6	9673	470
1	6	WI(RICL3A)-27	26	99	3380	75.7	34.9	21.1	9690	459
1	6	WI(RICL3A)-28	27	91	3249	75.6	34.0	24.0	9555	398
1	6	WI(RICL3A)-29	28	86	3315	75.7	35.0	19.9	9478	476
1	6	WI(RICL3A)-30	29	97	3287	75.3	35.2	25.6	9350	365
1	6	WI(RICL3A)-31	30	89	3280	76.2	34.0	25.7	9646	375
1	7	WI(RICL3A)-32	31	94	3725	75.7	36.9	23.0	10103	439
1	7	WI(RICL3A)-33	32	89	3514	76.7	37.6	19.8	9338	472
1	7	WI(RICL3A)-34	33	91	3488	75.2	33.9	22.6	10279	455
1	7	WI(RICL3A)-35	34	91	3486	76.4	36.3	25.7	9612	374
1	7	WI(RICL3A)-36	35	94	3409	75.1	37.0	25.2	9206	365
1	8	WI(RICL3A)-37	36	94	3474	76.2	36.8	23.4	9453	404
1	8	WI(RICL3A)-38	37	102	3459	76.4	38.3	24.8	9029	364
1	8	WI(RICL3A)-39	38	94	3914	76.1	36.5	20.1	10718	533
1	8	WI(RICL3A)-40	39	97	3379	76.6	33.7	17.0	10043	591
1	8	WI(RICL3A)-41	40	89	3801	74.3	34.0	21.5	11181	520
1	9	WI(RICL3A)-42	41	89	4022	74.0	34.2	21.3	11752	552
1	9	WI(RICL3A)-43	42	97	3592	75.7	36.0	23.2	9992	431
1	9	WI(RICL3A)-44	43	94	3593	75.6	30.9	22.8	11636	510
1	9	WI(RICL3A)-45	44	94	3694	75.5	33.6	21.3	11003	517
1	9	WI(RICL3A)-46	45	102	4069	76.0	35.3	27.4	11529	421
1	10	WI(RICL3A)-47	46	94	3923	75.6	36.8	22.5	10649	473
1	10	WI(RICL3A)-48	47	94	3765	74.0	36.0	22.9	10451	456

1	10	WI(RICL3A)-49	48	97	3962	76.2	37.5	23.6	10554	447
1	10	WI(RICL3A)-50	49	86	3825	75.1	34.4	19.4	11109	573
1	10	WI(RICL3A)-51	50	91	3695	74.8	34.0	21.3	10871	510
1	11	WI(RICL3A)-52	51	91	3549	77.1	35.8	21.5	9921	461
1	11	WI(RICL3A)-53	52	97	2829	77.1	35.6	21.4	7944	371
1	11	WI(RICL3A)-54	53	91	3546	76.2	34.4	24.1	10309	428
1	11	WI(RICL3A)-55	54	97	3929	76.1	37.2	27.7	10575	382
1	11	WI(RICL3A)-56	55	89	3520	75.7	34.5	19.3	10215	529
1	12	WI(RICL3A)-57	56	86	3301	76.7	37.6	23.1	8786	380
1	12	WI(RICL3A)-58	57	91	3267	76.2	33.3	21.1	9819	465
1	12	WI(RICL3A)-59	58	91	3631	77.1	35.7	21.1	10160	482
1	12	WI(RICL3A)-60	59	89	3100	75.5	35.9	24.4	8635	354
1	12	WI(RICL3A)-61	60	86	3702	76.0	35.0	24.3	10583	436
1	13	WI(RICL3A)-62	61	94	3555	75.1	34.2	22.3	10404	467
1	13	WI(RICL3A)-63	62	94	3865	76.2	35.9	25.6	10755	420
1	13	WI(RICL3A)-64	63	89	3286	75.2	36.6	21.3	8985	422
1	13	WI(RICL3A)-65	64	89	3799	75.8	37.3	24.2	10182	421
1	13	WI(RICL3A)-66	65	89	3571	76.5	35.0	23.1	10210	442
1	14	WI(RICL3A)-67	66	89	3384	76.5	35.1	23.5	9650	411
1	14	WI(RICL3A)-68	67	91	3681	76.0	35.0	20.9	10523	504
1	14	WI(RICL3A)-69	68	94	3557	75.7	36.9	23.9	9649	404
1	14	WI(RICL3A)-70	69	91	3705	74.9	35.7	23.7	10378	438
1	14	WI(RICL3A)-71	70	89	3744	76.4	33.3	23.9	11240	470
1	15	WI(RICL3A)-72	71	91	3710	75.6	36.4	25.3	10181	402
1	15	WI(RICL3A)-73	72	91	4009	75.6	36.0	24.0	11136	464
1	15	WI(RICL3A)-74	73	91	3503	75.6	37.1	26.1	9446	362
1	15	WI(RICL3A)-75	74	94	3844	75.8	36.7	24.0	10470	436
1	15	WI(RICL3A)-76	75	94	4009	76.6	35.4	22.2	11337	511
1	16	WI(RICL3A)-77	76	91	3724	77.4	39.0	23.0	9560	416
1	16	WI(RICL3A)-78	77	97	3166	76.1	38.2	29.5	8280	281
1	16	WI(RICL3A)-79	78	91	3833	75.7	36.6	24.1	10485	435
1	16	WI(RICL3A)-80	79	91	3874	76.7	36.8	22.4	10519	470
1	16	WI(RICL3A)-81	80	84	3411	76.1	37.2	23.6	9180	389
1	17	WI(RICL3A)-82	81	84	3323	75.6	37.7	21.8	8812	404
1	17	WI(RICL3A)-83	82	97	3632	75.1	37.9	26.1	9575	367
1	17	WI(RICL3A)-84	83	97	3235	76.7	38.0	27.4	8507	310
1	17	WI(RICL3A)-85	84	97	3101	77.0	35.9	24.0	8643	360
1	17	WI(RICL3A)-86	85	91	3829	75.2	36.4	26.3	10535	401
1	18	WI(RICL3A)-87	86	94	3317	76.5	34.0	21.6	9760	452
1	18	WI(RICL3A)-88	87	86	3407	75.1	33.5	21.3	10177	478
1	18	WI(RICL3A)-89	88	84	3225	75.3	34.2	21.0	9420	449
1	18	WI(RICL3A)-90	89	86	3449	75.1	32.8	24.3	10528	433
1	18	WI(RICL3A)-91	90	91	3518	76.7	36.1	27.9	9747	349
1	19	WI(CNN3A)	91	102	3524	74.0	37.8	24.7	9318	377
1	19	WI(CNN6A)	92	91	2721	76.0	37.0	20.9	7356	352
1	19	WI	93	91	4046	75.6	33.8	19.6	11980	611
1	19	CNN	94	101	3508	79.6	32.7	21.5	10712	498
1	19	CNN(WI3A)	95	84	3686	79.3	34.2	23.1	10765	466
1	20	CNN(WI6A)	96	99	3592	78.4	35.4	27.9	10145	364
1	20	Pronghorn	97	97	3965	78.0	36.6	27.6	10834	393
1	20	Jagger	98	86	4200	77.4	37.4	29.0	11225	387
1	20	Overland	99	81	4064	77.0	34.7	29.6	11713	396
1	20	Goodstreak	100	97	4729	79.3	35.9	21.3	13167	618

2	16	WI(RICL3A)-1	1	94	4036	75.7	37.5	24.7	10776	436
2	11	WI(RICL3A)-2	2	94	3979	76.5	35.2	24.8	11304	456
2	7	WI(RICL3A)-3	3	89	4663	77.1	36.8	26.5	12687	479
2	19	WI(RICL3A)-4	4	99	3838	76.7	32.2	21.0	11924	568
2	18	WI(RICL3A)-5	5	94	3589	77.5	31.3	22.5	11454	509
2	18	WI(RICL3A)-6	6	94	3531	76.2	34.3	21.2	10283	485
2	9	WI(RICL3A)-7	7	94	4058	77.0	35.2	21.7	11525	531
2	14	WI(RICL3A)-8	8	94	4073	76.0	36.9	24.8	11027	445
2	12	WI(RICL3A)-9	9	104	3337	77.4	36.7	22.6	9086	402
2	6	WI(RICL3A)-10	10	94	3815	75.7	33.4	21.4	11435	534
2	5	WI(RICL3A)-11	11	86	3686	77.1	35.6	23.8	10358	435
2	3	WI(RICL3A)-12	12	97	3734	76.9	36.7	25.2	10172	404
2	15	WI(RICL3A)-13	13	97	3080	75.5	34.3	24.6	8987	365
2	9	WI(RICL3A)-14	14	99	3788	76.2	36.9	24.5	10267	419
2	7	WI(RICL3A)-15	15	91	4122	75.3	33.2	23.3	12409	533
2	8	WI(RICL3A)-16	16	102	3771	75.8	36.2	21.3	10418	489
2	11	WI(RICL3A)-17	17	99	3786	77.5	37.3	28.5	10142	356
2	20	WI(RICL3A)-18	18	99	3903	77.7	35.5	22.3	10990	493
2	2	WI(RICL3A)-19	19	91	3765	74.7	34.6	23.9	10868	455
2	6	WI(RICL3A)-20	20	79	3346	74.7	33.4	23.9	10022	419
2	10	WI(RICL3A)-21	21	91	3731	77.5	37.6	24.7	9921	402
2	14	WI(RICL3A)-22	22	94	3966	75.7	36.4	22.9	10891	476
2	2	WI(RICL3A)-23	23	97	4168	75.5	33.3	24.0	12504	521
2	1	WI(RICL3A)-25	24	89	4051	75.7	33.8	25.0	11972	479
2	7	WI(RICL3A)-26	25	97	3948	77.4	38.3	27.8	10316	371
2	9	WI(RICL3A)-27	26	99	3570	77.3	37.0	22.8	9645	423
2	13	WI(RICL3A)-28	27	97	3993	74.2	34.5	26.5	11565	436
2	11	WI(RICL3A)-29	28	91	3649	74.8	33.9	25.3	10761	425
2	10	WI(RICL3A)-30	29	94	3582	74.7	35.7	22.2	10039	452
2	4	WI(RICL3A)-31	30	84	3481	74.6	34.8	23.5	10001	426
2	6	WI(RICL3A)-32	31	94	3695	77.3	39.0	24.0	9474	395
2	4	WI(RICL3A)-33	32	89	3565	76.5	34.7	22.0	10280	467
2	13	WI(RICL3A)-34	33	94	3911	75.7	36.6	27.7	10684	386
2	3	WI(RICL3A)-35	34	91	3408	77.0	35.7	28.7	9552	333
2	19	WI(RICL3A)-36	35	97	3722	74.3	30.7	25.7	12107	471
2	1	WI(RICL3A)-37	36	94	3619	76.9	35.6	23.2	10178	439
2	20	WI(RICL3A)-38	37	104	3995	77.1	33.7	23.5	11868	505
2	18	WI(RICL3A)-39	38	91	3620	76.1	33.7	25.0	10737	429
2	15	WI(RICL3A)-40	39	97	2548	75.1	35.2	25.4	7248	285
2	13	WI(RICL3A)-41	40	94	4050	76.2	34.4	21.6	11775	545
2	17	WI(RICL3A)-42	41	97	3788	74.8	31.9	21.6	11858	549
2	9	WI(RICL3A)-43	42	102	4196	75.6	35.9	21.1	11695	554
2	19	WI(RICL3A)-44	43	97	3782	75.3	31.5	20.5	12022	586
2	20	WI(RICL3A)-45	44	89	3765	74.8	32.4	21.0	11611	553
2	2	WI(RICL3A)-46	45	94	3666	76.5	37.5	20.9	9773	468
2	18	WI(RICL3A)-47	46	91	3992	75.1	33.8	24.3	11816	486
2	3	WI(RICL3A)-48	47	89	3998	74.4	34.9	26.5	11452	432
2	5	WI(RICL3A)-49	48	97	3534	76.7	36.1	24.1	9801	407
2	8	WI(RICL3A)-50	49	86	3507	76.2	33.0	21.4	10615	496
2	10	WI(RICL3A)-51	50	86	3478	76.0	37.8	22.5	9195	409
2	6	WI(RICL3A)-52	51	91	3853	77.1	37.5	27.8	10290	370
2	12	WI(RICL3A)-53	52	102	2841	78.4	35.7	19.5	7949	408
2	15	WI(RICL3A)-54	53	94	3426	74.9	34.4	23.0	9950	433

2	17	WI(RICL3A)-55	54	99	3855	76.5	34.4	26.7	11200	419
2	10	WI(RICL3A)-56	55	86	3174	76.4	35.3	21.8	8997	413
2	16	WI(RICL3A)-57	56	89	3571	76.2	37.4	25.3	9549	377
2	9	WI(RICL3A)-58	57	97	3831	76.2	33.3	22.8	11509	505
2	5	WI(RICL3A)-59	58	94	3939	76.6	38.3	27.6	10284	373
2	6	WI(RICL3A)-60	59	94	3357	76.6	36.1	26.1	9300	356
2	1	WI(RICL3A)-61	60	94	4038	75.3	35.7	24.2	11310	467
2	16	WI(RICL3A)-62	61	89	3620	75.8	34.9	24.7	10373	420
2	20	WI(RICL3A)-63	62	97	3965	76.5	35.0	20.8	11329	545
2	3	WI(RICL3A)-64	63	84	3932	74.9	34.8	22.9	11296	493
2	10	WI(RICL3A)-65	64	84	3680	76.1	36.9	23.3	9969	428
2	14	WI(RICL3A)-66	65	91	3614	76.1	36.2	25.1	9991	398
2	16	WI(RICL3A)-67	66	91	3613	75.1	34.3	22.3	10546	473
2	7	WI(RICL3A)-68	67	97	4018	76.2	35.3	22.8	11395	500
2	17	WI(RICL3A)-69	68	99	3671	76.4	35.4	24.4	10378	425
2	8	WI(RICL3A)-70	69	91	3807	74.8	34.8	23.0	10931	475
2	13	WI(RICL3A)-71	70	97	4161	76.5	36.6	28.4	11363	400
2	2	WI(RICL3A)-72	71	94	3773	76.5	37.3	26.0	10112	389
2	15	WI(RICL3A)-73	72	94	3009	76.0	37.1	25.5	8111	318
2	4	WI(RICL3A)-74	73	94	3697	76.4	37.1	27.5	9969	363
2	16	WI(RICL3A)-75	74	94	3787	77.1	36.5	24.2	10379	429
2	18	WI(RICL3A)-76	75	91	3687	77.5	36.5	26.6	10101	380
2	8	WI(RICL3A)-77	76	94	3472	77.7	34.6	22.3	10029	450
2	14	WI(RICL3A)-78	77	97	3321	73.9	35.1	25.0	9466	379
2	19	WI(RICL3A)-79	78	99	3766	75.2	32.0	23.9	11780	493
2	15	WI(RICL3A)-80	79	94	3625	76.4	37.1	23.0	9775	425
2	1	WI(RICL3A)-81	80	91	3821	75.7	35.2	21.8	10846	498
2	3	WI(RICL3A)-82	81	89	3670	74.6	38.1	23.7	9644	407
2	1	WI(RICL3A)-83	82	99	3844	76.4	36.7	24.5	10475	428
2	17	WI(RICL3A)-84	83	94	3693	76.4	31.9	20.9	11571	554
2	11	WI(RICL3A)-85	84	91	3246	76.7	35.1	22.5	9257	411
2	12	WI(RICL3A)-86	85	97	4025	76.1	34.7	25.9	11594	448
2	20	WI(RICL3A)-87	86	102	3687	76.2	31.8	19.6	11599	592
2	4	WI(RICL3A)-88	87	89	3631	75.2	34.8	24.6	10447	425
2	12	WI(RICL3A)-89	88	89	3735	75.5	33.9	21.3	11033	518
2	8	WI(RICL3A)-90	89	91	3466	76.1	35.1	20.0	9874	494
2	7	WI(RICL3A)-91	90	94	3455	76.7	37.9	21.9	9126	417
2	11	WI(CNN3A)	91	99	3367	74.7	36.5	20.8	9215	443
2	14	WI(CNN6A)	92	91	3310	76.6	36.6	23.4	9047	387
2	17	WI	93	97	3642	76.0	34.3	20.9	10617	508
2	5	CNN	94	102	3822	80.6	33.6	22.8	11675	512
2	4	CNN(WI3A)	95	81	3803	80.1	34.8	26.1	10930	419
2	2	CNN(WI6A)	96	94	3877	78.4	38.8	24.4	9990	409
2	13	Pronghorn	97	97	4467	77.7	31.1	23.8	14366	604
2	5	Jagger	98	79	3993	77.0	32.9	24.3	12128	499
2	19	Overland	99	86	4907	77.7	34.1	25.3	14385	569
2	12	Goodstreak	100	97	4251	80.4	33.7	24.6	12615	513
3	18	WI(RICL3A)-1	1	89	3769	77.0	35.9	25.4	10509	414
3	7	WI(RICL3A)-2	2	97	3321	76.7	32.3	23.2	10287	443
3	9	WI(RICL3A)-3	3	94	3464	76.6	31.3	24.9	11059	444
3	19	WI(RICL3A)-4	4	91	3346	77.9	38.2	23.0	8765	381
3	17	WI(RICL3A)-5	5	102	3591	76.9	31.4	27.8	11448	412
3	14	WI(RICL3A)-6	6	94	3566	76.5	34.2	19.3	10443	541

3	13	WI(RICL3A)-7	7	97	3565	76.6	33.9	22.2	10523	474
3	20	WI(RICL3A)-8	8	91	3298	75.5	34.2	22.3	9639	432
3	7	WI(RICL3A)-9	9	104	3412	76.9	35.1	21.1	9730	461
3	11	WI(RICL3A)-10	10	99	3606	76.7	31.5	26.6	11460	431
3	4	WI(RICL3A)-11	11	94	3364	77.5	33.4	21.5	10060	468
3	7	WI(RICL3A)-12	12	97	3439	77.3	34.3	20.0	10028	501
3	11	WI(RICL3A)-13	13	97	3419	76.2	33.8	23.7	10127	427
3	19	WI(RICL3A)-14	14	97	2719	76.5	33.4	19.7	8141	413
3	20	WI(RICL3A)-15	15	91	4033	75.8	32.5	23.7	12397	523
3	3	WI(RICL3A)-16	16	94	3740	76.9	33.6	20.7	11138	538
3	12	WI(RICL3A)-17	17	97	3525	76.0	36.3	24.7	9707	393
3	9	WI(RICL3A)-18	18	104	3892	76.2	35.7	23.3	10900	468
3	10	WI(RICL3A)-19	19	104	3186	75.8	29.3	23.0	10888	473
3	6	WI(RICL3A)-20	20	76	3334	76.2	28.6	20.4	11668	572
3	12	WI(RICL3A)-21	21	91	3976	77.0	35.7	25.6	11137	435
3	7	WI(RICL3A)-22	22	102	3492	74.9	30.1	24.2	11592	479
3	15	WI(RICL3A)-23	23	102	3851	76.4	33.6	21.4	11477	536
3	6	WI(RICL3A)-25	24	97	3464	77.7	34.3	19.9	10107	508
3	13	WI(RICL3A)-26	25	102	3177	77.0	35.3	25.4	9006	355
3	17	WI(RICL3A)-27	26	99	3442	75.7	32.8	23.0	10501	457
3	15	WI(RICL3A)-28	27	97	3488	75.1	32.1	22.1	10871	492
3	8	WI(RICL3A)-29	28	99	3343	74.8	30.4	25.1	11013	439
3	9	WI(RICL3A)-30	29	102	3239	74.7	32.8	23.8	9885	415
3	14	WI(RICL3A)-31	30	91	3361	75.6	34.1	23.7	9845	415
3	1	WI(RICL3A)-32	31	86	3422	77.5	35.6	25.7	9600	374
3	20	WI(RICL3A)-33	32	94	3367	76.9	33.7	19.9	9984	502
3	10	WI(RICL3A)-34	33	99	3392	73.8	29.6	20.2	11477	568
3	2	WI(RICL3A)-35	34	97	3505	77.0	30.9	24.8	11346	458
3	11	WI(RICL3A)-36	35	104	3416	75.8	35.9	23.9	9504	398
3	9	WI(RICL3A)-37	36	104	3128	75.2	34.4	19.2	9087	473
3	7	WI(RICL3A)-38	37	109	3812	77.4	31.7	27.5	12020	437
3	12	WI(RICL3A)-39	38	94	4073	77.1	36.4	22.8	11203	491
3	19	WI(RICL3A)-40	39	91	2722	77.3	34.3	25.1	7946	317
3	13	WI(RICL3A)-41	40	91	3619	76.2	33.5	21.2	10789	509
3	2	WI(RICL3A)-42	41	94	3728	75.8	34.0	21.8	10968	503
3	18	WI(RICL3A)-43	42	99	3248	76.1	33.0	23.3	9854	423
3	14	WI(RICL3A)-44	43	99	3397	75.8	33.9	25.1	10030	400
3	20	WI(RICL3A)-45	44	94	3295	75.8	33.1	22.5	9964	443
3	1	WI(RICL3A)-46	45	97	3617	77.3	38.8	28.0	9335	333
3	15	WI(RICL3A)-47	46	94	3490	76.2	32.8	27.2	10631	391
3	13	WI(RICL3A)-48	47	97	3073	74.4	30.3	20.4	10161	498
3	6	WI(RICL3A)-49	48	102	3785	76.2	32.0	25.6	11817	462
3	8	WI(RICL3A)-50	49	89	3355	75.3	31.4	22.6	10679	473
3	5	WI(RICL3A)-51	50	94	3826	76.0	33.1	22.5	11556	514
3	4	WI(RICL3A)-52	51	97	4115	77.7	35.0	24.8	11744	474
3	8	WI(RICL3A)-53	52	112	2840	77.3	30.1	30.3	9435	311
3	10	WI(RICL3A)-54	53	94	3357	75.5	30.6	22.0	10991	500
3	16	WI(RICL3A)-55	54	102	3310	76.7	32.0	23.6	10334	438
3	3	WI(RICL3A)-56	55	91	3547	76.4	33.8	22.9	10493	458
3	3	WI(RICL3A)-57	56	91	3329	75.6	31.3	19.9	10635	534
3	15	WI(RICL3A)-58	57	99	3180	77.5	30.1	20.8	10566	508
3	16	WI(RICL3A)-59	58	97	3269	76.5	34.4	19.0	9497	500
3	5	WI(RICL3A)-60	59	86	4012	75.5	36.4	24.5	11020	450

3	8	WI(RICL3A)-61	60	89	3172	76.0	32.0	29.3	9930	339
3	4	WI(RICL3A)-62	61	91	3680	76.1	32.4	21.1	11368	539
3	11	WI(RICL3A)-63	62	99	3924	76.9	35.0	22.8	11197	491
3	18	WI(RICL3A)-64	63	86	2713	75.3	35.7	24.2	7599	314
3	16	WI(RICL3A)-65	64	86	3313	74.7	33.4	21.3	9924	466
3	19	WI(RICL3A)-66	65	89	3057	76.9	35.4	22.4	8634	385
3	10	WI(RICL3A)-67	66	94	3647	75.6	31.3	19.9	11648	585
3	12	WI(RICL3A)-68	67	99	3377	76.5	33.1	19.3	10217	529
3	5	WI(RICL3A)-69	68	102	3443	76.4	34.2	23.4	10070	430
3	1	WI(RICL3A)-70	69	89	3433	75.2	33.7	18.6	10199	548
3	6	WI(RICL3A)-71	70	94	3619	77.8	33.3	28.2	10868	385
3	5	WI(RICL3A)-72	71	97	3713	75.1	35.4	21.0	10481	499
3	1	WI(RICL3A)-73	72	91	4103	76.9	35.4	24.2	11601	479
3	16	WI(RICL3A)-74	73	97	3393	77.3	31.1	21.4	10919	510
3	2	WI(RICL3A)-75	74	94	3539	76.9	34.0	17.4	10418	599
3	6	WI(RICL3A)-76	75	97	4037	76.4	35.8	26.3	11272	429
3	16	WI(RICL3A)-77	76	97	3117	78.0	34.7	18.0	8976	499
3	2	WI(RICL3A)-78	77	99	3244	75.6	36.2	25.0	8961	358
3	4	WI(RICL3A)-79	78	94	3528	75.7	35.4	25.0	9966	399
3	18	WI(RICL3A)-80	79	94	3137	77.3	36.1	23.1	8690	376
3	5	WI(RICL3A)-81	80	89	3806	74.8	33.5	23.6	11370	482
3	14	WI(RICL3A)-82	81	91	3115	76.2	36.2	22.0	8599	391
3	17	WI(RICL3A)-83	82	99	3826	75.8	35.4	23.4	10813	462
3	20	WI(RICL3A)-84	83	97	3185	77.3	31.2	23.4	10210	436
3	13	WI(RICL3A)-85	84	97	3391	77.1	34.1	18.8	9947	529
3	15	WI(RICL3A)-86	85	94	3599	75.7	31.7	23.2	11345	489
3	17	WI(RICL3A)-87	86	99	3476	76.9	31.0	25.3	11230	444
3	18	WI(RICL3A)-88	87	94	2924	75.2	33.7	25.0	8671	347
3	19	WI(RICL3A)-89	88	86	2792	77.1	35.3	21.6	7915	366
3	2	WI(RICL3A)-90	89	91	3362	76.9	34.1	23.8	9867	415
3	14	WI(RICL3A)-91	90	94	3202	77.1	35.4	22.0	9043	411
3	3	WI(CNN3A)	91	101	3083	73.6	31.9	20.2	9670	479
3	1	WI(CNN6A)	92	89	2896	77.1	32.6	15.2	8894	585
3	11	WI	93	97	3793	75.2	34.6	18.2	10957	602
3	10	CNN	94	104	3456	80.5	27.6	23.7	12544	529
3	4	CNN(WI3A)	95	86	3934	79.1	30.1	24.8	13077	527
3	8	CNN(WI6A)	96	104	3657	79.2	31.5	27.0	11603	430
3	3	Pronghorn	97	89	4594	78.7	29.3	21.4	15705	734
3	12	Jagger	98	81	4419	78.2	34.5	27.9	12816	459
3	17	Overland	99	84	4644	76.4	31.9	30.7	14577	475
3	9	Goodstreak	100	102	4708	80.1	29.5	22.8	15972	701