الاداء وقوة الهجين للتراكيب الوراثية في الحاصل ومكوناته للذرة الصفراء تحت ثلاث مواعيد للزراعة

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الخلاصة

اجري تضريب بين سبع سلالات وثلاث كشافات من الذرة الصفراء وفق تضريب السلالة × كشاف لانتاج 21 هجين في الموسم الخريفي 2016. زرعت بذور الاباء والهجن وفق تصميم القطاعات الكاملة المعشاة وبثلاث مكررات في ثلاث مواعيد للزراعة خلال الموسم الربيعي والخريفي 2017 وذلك في محطة أبحاث أبي غريب التابع لوزارة الزراعة. هدفت الدراسة إلى تقييم الأداء وقوة الهجين للهجن في جميع الصفات المدروسة. أظهر تحليل التباين وجود أختلافات معنوية لمتوسط المربعات للتراكيب الوراثية في جميع الصفات المدروسة وللموسمين. أظهر الهجين (L6 * T1)في موعد الزراعة الأول والثاني، والهجين (L4 * T1) في موعد الزراعة الثالث أعلى معدل لحاصل حبوب النبات خلال الموسم الربيعي (307.7) و (267.33) و (204 غم /نبات) على التوالي. في حين أظهر الهجين (L4 * T2) حاصل أعلى في الموسم الخريفي لموعد الزراعة الاول (225.3 غم/ نبات) والثاني (349.7 غم /نبات) و(L10*T1) (303.67 غم /نبات) لموعد الزراعة الثالث، وهذا يبين أمكانية استخدامهم للتقييم المستقبلي في برامج تربية الذرة الصفراء. ولوحظ وجود تباين لقوة الهجين لجميع الصفات المدروسة. بالنسبة لحاصل الحبوب، سجيل الهجين (L6*T2) أعلى قوة هجين موجبة ومعنوية بلغت 102.848% في الموعد الزراعي الاول و100.668% في الموعد الزراعي الثالث , وسجل الهجين (L8 * T3) اعلى قوة هجين موجبة ومعنوية بلغت (102.378%) في الموعد الزراعة الثاني للموسم الربيعي, اما في الموسم الخريفي فقد اظهر الهجين (L10*T2) اعلى قوة هجين في الموعد الزراعي الاول بلغت (86.430%)واظهر الهجين (L10*T1) اعلى قوة هجين موجبة ومعنوية في الموعد الزراعي الثاني والثالث بلغت 69.246% و 92.598% على التوالي. هذا يشير إلى وجود قوة هجين عالية لهذين الهجينين يمكن استغلالها في برامج التربية والتحسين.

الكلمات المفتاحية: الاداء, قوة الهجين, السلالة, السلالة × كشاف وحاصل الحبوب،الذرة، مواعيد الزراعة

The performance and heterosis of genotypes for yield and yield components in Maize(*Zea mays* L.) under three sowing dates

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Abstract

Seven inbred lines were crossing with three testers by using line x tester cross to produce twenty one hybrids of maize during autumn season 2016. The seeds of parents and hybrids were sown using Randomized Complete Block Design (RCBD) with three replicates in three sowing dates during spring and autumn 2017 at Abu-Ghraib Researches station. The objective of this study was to evaluate the test cross performance and estimate the amount of standard heterosis of the hybrids for grain yield and yield related traits. An analysis of variance indicated significant mean squares due to genotypes for all studies traites. Cross (L6*T1) at first and second sowing dates and crosses (L4*T1) at third sowing date showed the highest yield in spring season (307.7 g.p^{-1}, 267.33 g.p^{-1}), and (204 g.p^{-1}), respectively. Whereas, cross (L4*T2) showed higher yield in autumn season for first sowing date 225.3 g.p^{-1} and for second sowing date, (349.7 g.p^{-1}), While (L10*T1) gave highest mean (303.67 g.p^{-1}) for third sowing date, which could be utilized for future evaluation for possible release or used in maize breeding activities. Substantial standard heterosis was noticed for all studied traits. For grain yield (L6*T2) gave the highest standard heterosis (102.848%) at first sowing date and gave 100.668% at the third sowing date, followed by cross (L8*T3) with (102.378%) at second sowing date for spring season; While in the autumn season the hybrid (L10*T2) gave the highest hybrid vigor in first sowing date (86.430%) and the hybrid (L10*T1) gave the highest hybrid vigor in second and third sowing date (60.246 and 92.598%) respectively. this indicates the presence of substantial heterotic potential that could be exploited in maize breeding program .

Keywords: performance, heterosis, inbred line x tester, grain yield, Maize. Sowing dates

Introduction

Maize (*Zea mays* L.), belonging to the family Poaceae and tribe Maydeae, is one of the most important cereal crops and occupies a prominent position in global agriculture after wheat and rice because of its greater adaptability [1]. Heterosis is determined by the average performance of the two parents or high parent heterosis, hence the levels of differences between the parents is important. In breeding programs, heterosis can be exploited by generating lines from different heterotic groups and crossing them to produce a high yielding hybrid and heterotic groups can be identified through the knowledge of genetic distances between the inbred lines [2]. The magnitude of heterosis provides information on extent of genetic diversity of parents in developing superior F1s so as to exploit hybrid vigour and has direct bearing on the breeding methodology to be adapted for varietal improvement [3]. Heterosis is prerequisite for developing a good economically viable maize variety. Information on the heterotic patterns among maize germplasm is essential in maximizing the effectiveness of hybrid development [4 and 5]. The design has been widely used in maize breeding by several workers and continues to be applied in quantitative traits studies in maize due to its significance [6]. The level of heterosis depends on the parents chosen and trait measured which is why it is very important to select good parents [7]. Among the ever-changing components of the environment, the constantly rising ambient temperature is considered one of the most detrimental stresses. Temperature stress can reduce maize quality and yield; and any further rise in temperature reduces its pollen viability and silk receptivity, resulting in poor seed set and reduced grain yield [8 and 9]. This prediction is creating apprehension among scientists, as heat stress has known effects on the life processes of organisms, acting directly or through the modification of surrounding environmental components [10]. A plant is able, to some extent, to tolerate heat stress by physical changes within the plant body and frequently by creating signals for changing metabolism. In conditions such as HT, modification of physiological and biochemical processes by gene expression changes gradually leads to the development of heat tolerance in the form of acclimation, or in the ideal case, to adaptation [11 and 12]. However, the objective of this study was to evaluate of performance and estimate the heterosis for yield and yield components of maize genotypes, therefore, the present investigation was carried out to know the direction and magnitude of heterosis in maize.

Materials and Methods

Ten inbred lines were used in this study, sevsn inbred lines (4, 5, 6, 7, 8, 9 and 10) were used as lines and three inbred lines namely (1, 2 and 3) were used as testers. These lines were crossed together according to line x tester technique [13] to produce twenty one F1 hybrids. Field evaluation of 31 genotypes (21 F1 hybrids plus 10 parental inbred lines) was performed in Abu-Ghraib Researches station. They were crossed to develop twenty one F_1 crosses using line × tester mating design. The experimental population was kept under normal agronomic care from sowing to maturity. Necessary precautions were taken to avoid the contamination of genetic material at the time of crossing. The progenies along with their parents were evaluated in a randomized complete block design (RCBD) with three replicates for each from the first to the third sowing date. In each replication, 21 hybrids and 10 parents were raised; each plot was prepared with three rows 75 cm apart and 5 m in length, and consisted of 45 hills. The experiment was irrigated every five days. Fertilizers were applied prior to sowing at a rate of 120 kg Nitrogen(N) ha^{-1} and 140 kg Phosphor(P) ha^{-1}; and additional side dressing of 120 kg N ha^{-1} was added at the six leaves stage.

Planting Date

Heat stress affects plant quality characteristics and components of maize; therefore, planting was applied in three sowing dates and at two seasons (spring and autumn) during 2017. The seeds of the parents were planted manually and the pollination were carried out between the testers and the inbred lines. The pollination was regulated by the male inflorescences and the female silks flowers of the entering plants before the silk was released to prevent the open pollination process. Minimum and maximum means of air temperatures at pollination time were 16.23 ^{o}C – 30.7^{o}C in spring of 2017, which is considered low heat stress or normal conditions. During 2017, the first date of planting was March 7, in which the temperature equal to 7 ^{o}C - 25 ^{o}C. The second date of planting was March 17, in which the temperature equal to 8 ^{o}C- 23 ^{o}C. The third date of planting was March 27, in which the temperature equals to 13 ^{o}C- 28 ^{o}C. In autumn 2017, the first date of planting was July 20, in which the temperature equals to 30 ^{o}C - 47 ^{o}C (coinciding heat stress with pollination time and grain filling period), the second date was at July 30, in which the temperature equal to 30 ^{o}C - 48 ^{o}C (the normal planting date) to avoid high temperature during pollination and grain filling period, the third date was August 9, in which the temperature equals to 28 ^{o}C - 50 ^{o}C.

Data collection

The following traits were measured for the three planting date following the standard protocols used at CIMMYT [14]. Number of ears per plant(NEPP),Ear length (EL),Number of rows per ear (RPE),Number of kernels per row (NKR),1000 kernel weight (TKWT) and Grain yield per plant (GY).

Data Analysis:

Data from each sowing date were subjected to statistical analysis of variance(ANOVA) separately to detect the significance of genotypic differences under significant level ($p<0.05$). [15 and 16]

Estimation of standard heterosis

Standard heterosis percent was calculated for those traits that showed statistically significant differences among genotypes as suggested by [17]. This was computed as percentage increase or decrease of the cross performances as follows:

H (%) = $\frac{\mathrm{F1-BP}}{\mathrm{BP}} \times 100$ Where,

F1= Mean value of across, BP = Mean value of better parents

Test of significant for percent heterosis was calculated using the standard errors of the difference for heterosis as follows:

SE (d) = $(2Me/r)^{1/2}$ Where, SE (d) = standard error of the difference,Me = error mean square

r = number of replications[15]

Results and Discussion

Analysis of Variance

Analysis of variance showed that mean squares of the genotype which sown under each sowing date during spring and autumn seasons 2017 were highly significant for all studied traits(Table 1 and 2). This indicates that the crosses were sufficiently different from each other for these traits and hence, selection is possible to identify the most desirable crosses. This result was in agreement with previous investigators [18 and 19]. Similar results were obtained by [11, 20, 21].

Number of ears per plant

For spring season, the differences among the means square showed statistical significant differences (Table 1). The first sowing date indicated that number of ears per plant for parents ranged from 1.2067 with (L 9) to 1.3267 $ear.p^{-1}$ with (L4), while for hybrids ranged from 1.2533 with (L4*T3) to 1.3933 $ear.p^{-1}$ with (L6*T1). The second sowing date for parents ranged from 1.14 for (L5) to 1.2467 $ear.p^{-1}$ for (T1); in hybrids, the range was 1.22 with (L7*T3) to 1.36 $ear.p^{-1}$ with (L7*T2). The third sowing date for parents ranged from 1.14 to 1.1933 $ear.p^{-1}$ for (L9) and (L4), respectively. In hybrids, it ranged from 1.1633 with (L9*T2) to 1.2633 $ear.p^{-1}$ with (L8*T2) as shown in (Table 3). The parent (L4) recorded the highest numbers at first sowing date, whereas, the hybrid (L6*T1) was the highest at first sowing date. The first sowing date gave the maximum for number of ears per plant. For autumn season, the differences among the means square showed statistical significant differences (Table 2). The first sowing date revealed that number of ears per plant for parents ranged from 1.1633 with (T2,L9) to 1.2067 $ear.p^{-1}$ with (L4), but for hybrids it ranged from 1.19 for (L6*T3) to 1.2933 $ear.p^{-1}$ for (L10*T2). The second sowing date for parents ranged from 1.2467 with (L9) to 1.3667 $ear.p^{-1}$ with (T1); in hybrids it ranged from 1.3 for (L6*T1) to 1.4267 $ear.p^{-1}$ for (L7*T2 and L10*T1). The third sowing date ranged from 1.1733 for parents (L5) to 1.2733 $ear.p^{-1}$ for (T1), while in hybrids ranged from 1.2433 with (L8*T2 and L10*T3) to 1.3967 $ear.p^{-1}$ with (L7*T2) as presented in (Table 3). The parent (T1) recorded the highest of number ears per plant at second sowing date, and (L4) recorded the lowest at first sowing date; whereas, the hybrid (L7*T2 and L10*T1) was the highest at second sowing date. The current study results for the two seasons showed statistical significant differences among the means; this could be due to the differences of temperatures for the three different sowing dates, which had an impact on germination and vegetative growth. This might increase the plant height that reflected on the number of ears per plant. This the present results are in agreement with the findings of [3 and 19].

Ear length (cm)

For spring season, the differences among the means square showed statistical significant differences (Table 1). The first sowing date indicated that ear length for parents ranged from 14.467 with (L 6) to 16.533 cm with (T2, L9), while for hybrids ranged from 13.6 with (L8*T3) to 19.067 cm with (L8*T1). The second sowing date for parents ranged from 13.867 for (L6) to 16.867 cm for (L9); in hybrids, the range was 15.067 with (L10*T2) to 17.833cm with (L4*T1). The third sowing date for parents ranged from 12 to 13.767 cm for (L9) and (L5), respectively. In hybrids, it ranged from 11.8 with (L4*T2, L9*T3) to 14.867 cm with (L8*T1) as shown in (Table 3). The parent (L9) recorded the highest length at first sowing date, whereas, the hybrid (L8*T1) was the highest at first sowing date. The first sowing date gave the maximum for ear length. For autumn season, the differences among the means square showed statistical significant differences (Table 2). The first sowing date revealed that ear length for parents ranged from 16.133 with (T1) to 19.733 cm with (L9), but for hybrids it ranged from 15.93 for (L9*T2) to 19.267cm for (L5*T3). The second sowing date for parents ranged from 16.867 with (L10) to 19.6 cm with (L4); in hybrids it ranged from 16.867 for (L4*T3, L9*T3) to 20 cm for (L4*T2). The third sowing date for parents ranged from 15.73 for parents (T1) to 18.67 cm for (T1), while in hybrids ranged from 14.93 with (L10*T1) to 18.07 with (L8*T1) as presented in (Table 3). The parent (L9) recorded the highest of ear length at first sowing date, and (L5) recorded the lowest at third sowing date; whereas, the hybrid (L4*T2) was the highest at second sowing date. The obtained results indicated highly significant differences for ear length among lines and hybrids of maize, that could be attributed to the genetic material of parents and hybrids, as well as to the difference in dates of planting, which causes differences in temperature. The ear length has an effect on the final grain yield. The present results for the two seasons are in agreement with [22, 23, 24].

Number of rows per ear

For spring season, the differences among the means square showed statistical significant differences (Table 1). The first sowing date indicated that number of rows per ear for parents ranged from 15.233 row with (L 8) to 16.767 with (L4), while for hybrids ranged from 16.2 with (L10*T2) to 18.733 row with (L4*T2 and L6*T2). The second sowing date for parents ranged from 15.067 row for (T3, L7) to 16.4 row for (L4); in hybrids, the range was 15.6 with (L10*T2) to 18.233 row with (L4*T3). The third sowing date for parents ranged from 14.933 to 15.933 row for (L7) and (L4), respectively. In hybrids, it ranged from 15.1 row with (L10*T2) to 17.8 row with (L6*T1) as shown in (Table 4). The parent (L4) recorded the highest numbers of rows at first sowing date. Whereas, the hybrid (L4*T2 and L6*T2) was the highest at first sowing date. The first sowing date gave the maximum for plant height.

For autumn season, the differences among the means square showed statistical significant differences (Table 2). The first sowing date revealed that number of rows per ear for parents ranged from 15.233 row with (L7) to 16.2 row with (L4), but for hybrids it ranged from 15.933 for (L9*T3) to 18 row for (L10*T1). The second sowing date for parents ranged from 15.5 row with (L8) to 16.967 row with (L4); in hybrids it ranged from 16.467 row for (L9*T3) to 18.833 row for (L5*T1). The third sowing date ranged from 15.433 row for parents (T3) to 16.6 for (L7), while in hybrids ranged from 15.933 with (L9*T3) to 18.4 row with (L6*T1) as presented in (Table 4). The parent (L4) recorded the highest of number row per ear at second sowing date, and (L4) recorded the lowest at first sowing date; whereas, the hybrid (L5*T1) was the highest at second date. For three sowing dates, the differences among the means square showed statistical significant differences at the three sowing dates for rows per ear trait. This could be attributed to the genetic material of parents and hybrids, as well as to the difference in dates of planting, which causes differences in temperature. The first date in spring season and the second date in autumn season were the best; these two dates are ideal for maize growth. and the metabolism pathways. This might be due to metabolic pathways thatare diverted to invest more energy for stress tolerance [25]. The present results are in agreement with [11, 12] .

Number of kernels per row

For spring season, the differences among the means square showed statistical significant differences (Table 1). The first sowing date indicated that number of kernels per row for parents ranged from 32.2 grain with (L 7) to 41.5gr with (L4), while for hybrids ranged from 33 with (L9*T3) to 45.7gr with (L4*T1). The second sowing date for parents ranged from 30.8 grain for (T3) to 38.57gr for (L4); in hybrids, the range was 31.07 with (L9*T3) to 42.87 with (L4*T1). The third sowing date for parents ranged from 26.53 to 33.53 grain for (L7) and (L4), respectively. In hybrids, it ranged from 26.67 grain with (L9*T3) to 38.1 with (L6*T2) as shown in (Table 4). The parent (L4) recorded the highest numbers at first sowing date, whereas, the hybrid (L4*T1) was the highest at first sowing date. The first sowing date gave the maximum for number of kernels per row for autumn season, the differences among the means square showed statistical significant differences (Table 2). The first sowing date revealed that number of kernels per row for parents ranged from 29.57 grain with (L7) to 35.3 with (L5), but for hybrids it ranged from 30.43 for (L8*T2) to 40.27 for (

L4*T2). The second sowing date for parents ranged from 34.57 grain with (L7) to 43.4 with (L4); in hybrids it ranged from 35.5 cm for (L7*T3) to 49.27 for (L4*T2). The third sowing date ranged from 33.2 grain for parents (L7) to 41.43 for (L4), while in hybrids ranged from 32.8 with (L7*T3) to 45.67 with (L5*T1) as presented in (Table 4). The parent (L4) recorded the highest of number of kernels per rows at second sowing date, and (L7) recorded the lowest at first sowing date; whereas, the hybrid (L4*T2) was the highest at second date. For three sowing dates, the differences among the means showed statistical significant differences for the three sowing dates. This could be attributed to the genetic material of parents and hybrids, as well as to the difference in dates of planting, which causes differences in temperature. The first date in the spring season was the best, but in the autumn season the second date was the best. The optimum sowing date and better genetic material are needed for better quantities and for superior numbers of grains [26]. The results of the two seasons are in agreement with [3,24 and 25]

1000-grain weight (g)

For spring season, the differences among the means square showed statistical significant differences (Table 1). The first sowing date indicated that 1000-grain weight for parents ranged from 173.67 gm with (L 7) to 203 with (L4), while for hybrids ranged from 210.33 with (L10*T2) to 288.67 with (L4*T1). The second sowing date for parents ranged from 170.33 gm for (L7) to 197.33 for (L4); in hybrids, the range was 208 with (L10*T2) to 283.67 with (L4*T1). The third sowing date for parents ranged from 163.67 to 191.67 gm for (L7) and (L4), respectively. In hybrids, it ranged from 204 gm with (L10*T1) to 276 with (L4*T1) as shown in (Table 5). The parent (L4) recorded the highest weight at first sowing date. Whereas, the hybrid (L4*T1) was the highest at first sowing date. The first sowing date gave the maximum for plant height. For autumn season, the differences among the means square showed statistical significant differences (Table 2). The first sowing date revealed that 1000-grain weight for parents ranged from 166.67 gm with (L7) to 195 with (L4), but for hybrids it ranged from 213.67 for (L6*T3) to 278.33 for (L4*T1). The second sowing date for parents ranged from 182.67 gm with (L7) to 211with (L4); in hybrids it ranged from 216.67 gm for (L9*T3) to 293.67 for (L4*T1). The third sowing date ranged from 175 gm for parents (T3) to 200 for (L4), while in hybrids ranged from 216 with (L6*T3) to 281.67 with (L4*T1) as presented in (Table 5). The parent (L4) recorded the highest of weight at second sowing date, and (L7) recorded the lowest at first sowing date; whereas, the hybrid (L4*T1) was the highest at second sowing date. The differences among the means showed statistical significant differences at the three sowing dates for the two seasons. This could be attributed to the genetic material of parents and hybrids, as well as to the difference in dates of planting, which causes differences in temperature. The first date in the spring season was the best, but in the autumn season the second date was the best. This confirms that these two dates are ideal for growing maize. That heat stress deteriorates both qualitative and quantitative attributes of plant. This is because the plant metabolic pathways are diverted to invest more energy for stress tolerance [25]. Thus, the plants capable of having high stress tolerance ability also tend to show better nutritional quality [27, 28], the present results for two seasons are confirmed by [22].

Grain yield per plant ($g.p^{-1}$)

For spring season, the differences among the means square showed statistical significant differences (Table 1). The first sowing date indicated that grain yield for parents ranged from 106.3 with (L7) to 187.3 $g.p^{-1}$ with (L4), while for hybrids ranged from 160.37 gm with (L10*T2) to 307.7 $g.p^{-1}$ with (L6*T1). The second sowing date for parents ranged from 93.33 for (L7) to 151.67 $g.p^{-1}$ for (L4); in hybrids, the range was 132.33 with (L10*T2) to 267.33 $g.p^{-1}$ with (L6*T1). The third sowing date for parents ranged from 74 to 122.33 $g.p^{-1}$ for (L7) and (L4), respectively. In hybrids, it ranged from 108.67 with (L10*T2) to 204 $g.p^{-1}$ with (L4*T1) as shown in (Table 5). The parent (L4) recorded the highest mean forgrain yield at first sowing date, whereas, the hybrid (L6*T1) was the highest at first sowing date. The first sowing date gave the maximum for grain yield per plant. For autumn season, the differences among the means square showed statistical significant differences (Table 2). The first sowing date revealed that grain yield for parents ranged from 88.7 with (L7) to 128.7 $g.p^{-1}$ with (L4), but for hybrids it ranged from 130 for (L8*T3) to 255.3 $g.p^{-1}$ for (L4*T2). The second sowing date for parents ranged from 127.3 with (L7) to 211 $g.p^{-1}$ with (L4); in hybrids it ranged from 189.7 for (L6*T3 and L9*T3) to 349.7 $g.p^{-1}$ for (L4*T2). The third sowing date ranged from 108.67 for parents (L7) to 171.67 $g.p^{-1}$ for (L4), while in hybrids ranged from 151.67 with (L8*T3) to 303.67 $g.p^{-1}$ with (L10*T1) as presented in (Table 5). The parent (L4) recorded the highest of grain yield per plant at second sowing date, and (L7) recorded the lowest at first sowing date; whereas, the hybrid (L4*T2) was the highest at second date. For three sowing dates, the differences among the means showed statistical significant differences at all the sowing dates for grain yield per plant trait. This could be attributed to differences in temperature due to the difference in sowing dates, and as well differences the genetic material of parents and hybrids. All these reasons led to statistically significant differences in grain yield of the plant. Heat stress as a dehydrative force influences the physiological phenomena of cells and reduces the utilization of available essential nutrients [25 and 29]. Optimum sowing date and better genetic material are involved for greater quantities and crucial for superior nutritional quality of grains (Redfearn, 2010). The present results are in agreement with [11, 22 and 24]

Standard Heterosis

The results of heterosis% over better parent for various characters are presented in (Tables 6-8).

Number of ear per plant

For spring season, the highest negative values were -5.553% and -1.953% with hybrids (L4*T3) for the first and third sowing dates, respectively. On the other hand, the highest positive values were 9.811%, 13.023%, and 10.207% with hybrids (L7*T2) for the first, second, and third sowing date, respectively (Table 6). For autumn season, the data of the first date indicated that the highest negative value was -0.560% for the hybrid (L6*T3) and the highest positive value was 9.909% for the hybrid (L10*T2). In the second date, the highest negative value was -4.88% for (L6*T1) while the highest positive value was 10.881% for (L7*T2). In the third date, the highest negative value was -1.304% with (L6*T1) and the highest positive value was 13.858% for (L7*T2) as presented in (Table 6). The results revealed negative and positive heterosis in all sowing dates at both seasons; the values of positive heterosis were more than the negative ones. Among 21 hybrids, three showed negative heterosis at the first sowing date of spring season, while, at the third sowing date, only one hybrid showed negative heterosis. The results of this study are in conformity with the findings of [30, 31].

Ear length

For spring season, the data of the first sowing date indicated that the highest negative value was -15.321% for the hybrid (L10*T2) and the highest positive value was 25.553% for the hybrid (L5*T3). In the second sowing date, the highest negative value was -8.128 for (L10*T2) while the highest positive value was 18.621% for (L8*T1). In the third sowing date, the highest negative value was -12.835% with (L5*T3) and the highest positive value was 9.316% for (L8*T1) as presented in (Table 6). For autumn season, the highest negative values were -92.634%, -13.944%, and -13.699% with hybrids (L5*T3), (L4*T3), and (L10*T1) for the first, second, and third sowing dates, respectively. On the other hand, the highest positive values were 7.733%, 7.865%, and 12.027% with hybrids (L10*T3), (L5*T1), and (L7*T3) for the first, second, and third sowing dates, respectively (Table 6). The results of the standard heterosis for ear length indicated the existing of negative and positive heterosis in all sowing dates at both seasons. Among 21 hybrids, four hybrids gave positive heterosis at the third sowing date of autumn season; while, at the second sowing date, six hybrids gave negative heterosis. Negative heterosis indicates earliness, whereas, positive heterosis indicates lateness to reach physiological maturity. These findings are in agreement with [32, 33] reported both negative and positive significant heterosis for ear length.

Number of rows per ear

For spring season, the data of the first sowing date indicated that the highest negative value was -0.613% for the hybrid (L10*T2) and the highest positive value was 20.689% for the hybrid (L6*T3). In the second sowing date, the highest negative value was -3.106 for (L10*T2) while the highest positive value was 15.755% for (L6*T3). In the third sowing date, the highest negative value was -3.409% with (L10*T2) and the highest positive value was 14.940% for (L8*T3) as presented in (Table 7). For autumn season, the data of this trait indicated that there was no negative value for all sowing dates , the data of the first sowing date indicated that highest positive value was 12.500% for the hybrid (L10*T1). In the second sowing date, the highest positive value was 17.464% for (L5*T1). In the third sowing date, the highest positive value was 13.580% for (L6*T1) as presented in (Table 7). The standard heterosis for the number of rows per ear recorded significant positive results in all the studied hybrids except the hybrid (L4*T1) in second date and (L10*T2) in all sowing dates for spring season. The current findings confirmed previous reports; significant level of positive and negative heterosis for number rows per ear was reported by other investigators [31, 34].

Number of kernels per row

For spring season, the data of the first sowing date indicated that the highest negative value was -13.218% for the hybrid (L10*T1), and the highest positive value was 18.765% for the hybrid (L6*T2). In the second sowing date, the highest negative value was -15.135% for (L7*T2) while the highest positive value was 16.178% for (L6*T3). In the third sowing date, the highest negative value was-12.211% with (L10*T1) and the highest positive value was 20.57% for (L6*T2) as presented in (Table 7). For autumn season, the highest negative values were -13.477%, -14.977%, and -15.445% with hybrids (L8*T2), (L8*T1), and (L8*T2) for the first, second, and third sowing dates, respectively. On the other hand, the highest positive values were 14.501%, 13.525%, and 19.774% with hybrids (L4*T2), (L4*T2), and (L5*T1) for the first, second and third sowing dates, respectively (Table 7).For number of kernels per row, negative and positive heterosis were observed in all sowing dates to both seasons, Among the 21 studied hybrids, 12 showed significant positive heterosis at the first sowing date of spring season, while, at the third sowing date, ten hybrids showed positive heterosis.

The positive values indicate lateness whereas negative values indicate earliness physiological maturity, which indicating better performance. [34,35] also reported similar results in maize.

1000-grain weight

For spring season, no negative value for all sowing dates was observed. On the other hand, the highest positive values were 50.179%, 54.069%, and 57.592% with hybrids (L9*T3) for the first, second, and third sowing dates, respectively (Table 8). For autumn season, no negative value for all sowing dates was found. On the other hand, the highest positive values were 57.053%, 51.069%, and 53.773% with hybrids (L7*T3) for the first, second, and third sowing dates, respectively (Table 8). The hybrid (L9*T3) and (LY X T3)showed the highest values indicating the role of the parents (L9,L7 and T3) for the high values of this trait. Similar to the current study, significant level of positive heterosis for 1000 kernel weight in maize was reported by previous investigators [30, 33, 35].

Grain yield per plant

For spring season, the data of this trait indicated that there was no negative values for all sowing dates except the hybrid (L10*T1), which showed negative value at the three sowing dates -6.023%, -1.871% and -1.478% respectively. The data of the first sowing date indicated that highest positive value was 102.848% for the hybrid (L6*T2). In the second sowing date, the highest positive value was 102.378% for (L8*T3). In the third sowing date, the highest positive value was 100.668% for (L6*T2) as presented in (Table 8). For autumn season, the data indicated no negative values for all sowing dates. The results of the first sowing date indicated that highest positive value (86.430%) for the hybrid (L10*T2). In the second date, the highest positive value was 69.246% for (L10*T1). In the third date, the highest positive value was 92.598% for (L10*T1) as presented in (Table 8).The hybrids (L6*T2) and (L8*T3) showed the highest values, which indicated the role of the parents (L6 and L8) for the high values of this trait. In agreement with this study, significant level of positive heterosis for grain yield in maize has been reported by several investigators [30,34,35,37and 38].

Conclusion

The analysis of variance for maize parents and hybrids for the eleven quantitative characters revealed statistical significant differences indicating the presence of genetic variability among genotypes. Heterosis is revealed in several crosses for most of the characters in both desirable and undesirable direction.

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Table 1: Mean squares for studied traits of maize genotypes under three sowing dates at spring season 2017

Sources of variation	Df	Date	Mean squares					
			EPP	**EL**	**RPE**	**NKR**	**TKWT**	**GY**
Replication (R)	2	1	0.004766	1.1282	0.00462	3.532	47.65	120.7
		2	0.000878	3.819	0.10849	0.543	7.3	77.88
		3	0.0004591	0.2362	0.29043	1.938	1.00	16.69
Genotypes (G)	30	1	0.00652**	5.1269**	4.0633**	46.389**	3134.3*	10407.2**
		2	0.007925**	3.2486**	2.510**	40.794**	3268.45**	7414.35**
		3	0.0042**	1.4753**	2.036**	32.835**	3269.08**	4595.54**
Error (E)	60	1	0.00171	0.6099	0.0579	1.005	17.4	126.1
		2	0.001166	0.7589	0.0604	2.033	8.279	63.62
		3	0.0007214	0.5976	0.0633	3.895	11.77	82.29

Df= freedom degrees, *and**= Significant and highly significant, respectively, ns= non-significant, EPP= number of ear per plant, EL= ear length, RPE= number of rows per ear, NKR= number of kernels per row, TKWT= 1000 kernel weight, and GY= grain yield per plant.

Table 2: Mean squares for studied traits of maize genotypes under three sowing dates at autumn season 2017

Sources of variation	Df	Date	Mean squares					
			EPP	**EL**	**RPE**	**NKR**	**TKWT**	**GY**
Replication (R)	2	1	0.00073	1.5816	0.292	17.815	47.95	877.29
		2	0.00650	5.2288	0.05946	12.833	89.04	517.6
		3	0.00114	2.913	0.24656	32.172	19.48	1593.97
Genotypes (G)	30	1	0.00421**	2.5295**	1.7578**	27.308**	3309.57**	5269.38**
		2	0.00615**	2.1746**	3.591**	42.198**	3111.83**	11539.9**
		3	0.00838**	2.300*	2.2473**	48.607**	3070.17**	8944.4**
Error (E)	60	1	0.00088	0.8273	0.0688	2.417	40.44	93.18
		2	0.00209	0.8719	0.0499	2.347	31.61	216.4
		3	0.001156	1.362	0.060	1.68	20.04	79.80

Df= freedom degrees, *and**= Significant and highly significant, respectively, ns= non-significant, EPP= number of ear per plant, EL= ear length, RPE= number of rows per ear, NKR= number of kernels per row, TKWT= 1000 kernel weight, and GY= grain yield.

Table 3: Means for number of ears per plant and ear length for 31 maize genotypes that planted under three sowing dates during spring and autumn seasons of 2017

Line	Spring						Autumn					
	Number of ears per plant			Ear length(cm)			Number of ears per plant			Ear length(cm)		
	Date1	Date2	Date3	Date1	Date2	Date3	Date1	Date2	Date3	Date1	Date2	Date3
T1	1.3233	**1.2467**	1.17	14.667	14.5	12.633	1.1867	1.3667	1.2733	16.133	17.8	15.73
T2	1.2567	1.2033	1.1433	**16.533**	15.333	12.133	1.1633	1.28	1.2267	17.733	18.667	17

T3	1.24	1.19	1.17	14.933	16.6	12.8	1.1767	1.2833	1.22	17.2	18.6	18.07
L4	**1.3267**	1.2167	**1.1933**	14.667	15.933	12.8	1.2067	1.3567	1.2467	17.067	19.6	17.8
L5	1.23	**1.14**	1.1667	15.133	14.4	**13.767**	1.1767	1.2933	1.1733	16.733	17.8	18.67
L6	1.2533	1.19	1.1833	**14.467**	**13.867**	12.533	1.1967	1.2767	1.22	18.4	18.667	17.67
L7	1.2367	1.18	1.1433	15.467	16.2	12.467	1.18	1.2867	1.2133	18.067	17.333	17.13
L8	1.2767	1.19	1.1533	15.6	14.267	13.6	1.1867	1.31	1.2167	17.967	18.567	16.13
L9	**1.2067**	1.17	**1.14**	**16.533**	**16.867**	**12**	1.1633	1.2467	1.1867	19.733	18.933	18.07
L10	1.2567	1.2167	1.16	14.933	16.4	12.667	1.1767	1.2833	1.2467	16.867	16.867	17.3
L4*T1	1.3167	1.2667	1.2167	14.4	**17.833**	12.067	1.2433	1.3733	1.3	16.73	17.267	16.67
L4*T2	1.3633	1.29	1.2533	14.733	16.867	**11.8**	1.22	1.3533	1.32	17.53	20	15.6
L4*T3	**1.2533**	1.2267	1.17	17.333	15.333	12.867	1.26	1.3467	1.3167	17	16.867	18
L5*T1	1.3533	1.2767	1.2567	15.333	17.133	12.133	1.28	1.4	1.3233	16.53	19.2	17
L5*T2	1.3133	1.2633	1.2167	14.733	15.467	12.733	1.23	1.33	1.26	17.33	17.63	17.4
L5*T3	1.34	1.2767	1.2533	19	15.333	12	1.2033	1.36	1.2767	19.267	18.2	16.2
L6*T1	**1.3933**	1.3467	1.2067	15.067	15.133	13.667	1.1933	1.3	1.2567	17.53	19.267	17.33
L6*T2	1.32	1.29	1.1967	16.4	16.333	12.633	1.2733	1.3867	1.3633	16.73	17.53	15.87
L6*T3	1.3167	1.2333	1.21	14.467	16.933	12.8	1.19	1.3367	1.2867	18.6	18.067	17
L7*T1	1.3633	1.3433	1.2567	16.4	16.933	13.8	1.2733	1.38	1.31	17.6	17.13	17.2
L7*T2	1.38	**1.36**	1.26	15.133	16.467	12.667	1.2867	1.4267	1.3967	16.867	17.33	17.47
L7*T3	1.26	**1.22**	1.1767	15.4	16.267	12.2	1.2133	1.35	1.28	16	17.3	16.27
L8*T1	1.3233	1.2567	1.21	**19.067**	17.2	**14.867**	1.23	1.3467	1.29	17.467	17.93	18.07
L8*T2	1.3033	1.2933	**1.2633**	15.067	17.6	12.533	1.2033	1.3133	1.2433	17.53	18.53	17.47
L8*T3	1.3067	1.2833	1.2233	**13.6**	17.067	12.133	1.2033	1.3133	1.25	18.867	17.53	16.33
L9*T1	1.33	1.2467	1.17	15.4	16.2	13.267	1.2533	1.4	1.3033	17.53	18.4	17
L9*T2	1.2967	1.2433	**1.1633**	17.267	16.4	13.2	1.2367	1.3433	1.28	15.93	18.2	16.33
L9*T3	1.3	1.2567	1.1833	14.4	15.6	**11.8**	1.2133	1.3533	1.26	17.7	16.867	15.87
L10*T1	1.2767	1.2467	1.1867	14.533	17.267	13.133	1.2267	1.4267	1.38	17.33	17.13	14.93
L10*T2	1.3233	1.23	1.19	14	**15.067**	13.4	1.2933	1.34	1.3233	18.467	19.2	16.2
L10*T3	1.3367	1.2233	1.1867	16.4	17.2	13.467	1.2033	1.3667	1.2433	18.53	18.03	16.67
G.M	**1.3025**	**1.2457**	**1.1959**	**15.518**	**16.129**	**12.792**	1.2175	1.3397	1.2738	17.516	18.08	16.92
L.S.D	**0.067**	**0.056**	**0.044**	**1.275**	**1.423**	**1.262**	0.048	0.075	0.055	1.485	1.525	1.906

Table 4: Means for number of rows per ear and number of kernels per row for 31 maize genotypes that planted under three sowing dates during spring and autumn seasons of 2017

Line	**Spring**						**Autumn**					
	Number of rows per ear			**Number of kernels per row**			**Number of rows per ear**			**Number of kernels per row**		
	Date1	**Date2**	**Date3**	**Date1**	**Date2**	**Date3**	Date1	Date2	Date3	**Date1**	**Date2**	**Date3**
T1	16.5	16.033	15.8	39.87	37.57	32.43	16	16.7	16.2	34.37	43.2	38.13
T2	16.3	15.9	15.633	38.37	37	31.6	15.767	16.633	16.1	35.17	41.8	39.3
T3	15.267	**15.067**	15.1	32.9	**30.8**	29.6	15.333	15.9	15.433	33.07	35.63	33.6
L4	**16.767**	**16.4**	**15.933**	**41.5**	**38.57**	**33.53**	16.2	16.967	16.6	33.7	**43.4**	**41.43**
L5	15.767	15.6	15.2	36.57	35.17	32.03	15.5	16.033	15.9	**35.3**	39.43	36.63
L6	15.467	15.233	15.067	35.83	34.8	30.93	15.533	15.767	15.533	33.3	37.27	37.73
L7	15.333	**15.067**	**14.933**	**32.2**	30.87	**26.53**	15.233	15.7	15.533	**29.57**	**34.57**	**33.2**
L8	**15.233**	15.367	15.167	33.5	31.27	27.4	15.5	15.5	15.8	30.2	35.93	33.87
L9	15.267	15.233	15.333	35.27	33.13	28.43	15.6	15.6	15.5	30.8	37.43	35.97
L10	16.167	16.1	15.333	36.13	35	31.17	15.633	16.433	16.333	33.6	38.27	37.23
L4*T1	17	16.367	16.1	**45.7**	**42.87**	37.7	16.267	17.167	16.667	36.6	47.4	45.37
L4*T2	**18.733**	17.333	17.267	43.57	41.17	37.17	17.133	18.8	17.467	**40.27**	**49.27**	45.3
L4*T3	18.7	**18.233**	17.467	41.57	38.03	34.73	17.667	18.7	17.867	34.43	41.13	37.93
L5*T1	17.233	16.633	16.067	35.47	34.53	31.23	17.4	18.833	17.533	39.87	42	**45.67**
L5*T2	17.467	17.1	16.833	34.17	31.7	29.53	17.5	18.733	17.7	37.13	43.67	44.07
L5*T3	17.667	17.233	16.533	41.13	38.9	32.4	16.267	16.933	16.633	32.53	39.8	37.4
L6*T1	18.567	18.167	**17.8**	44.57	41.87	36.37	17.667	18.767	18.4	37.7	43.37	42.6
L6*T2	**18.733**	17.433	16.967	45.57	42.13	**38.1**	16.633	18.6	17.767	36.37	41.27	40.83
L6*T3	18.667	17.633	17.233	41.7	40.43	35.97	16.367	16.733	16.433	32.97	38.6	37.03
L7*T1	18.5	17.6	16.4	39.9	37.83	33.57	16.267	17.433	16.867	35.87	38.83	37.1

L7*T2	16.733	16.3	15.933	34.4	31.4	29.73	16.2	16.833	16.6	31.53	36.57	34.5
L7*T3	17.167	16.6	16.233	33.3	32.33	27.6	16.767	16.733	16.633	31.03	**35.5**	**32.8**
L8*T1	17.7	17.233	16.767	36.6	33.9	29.1	16.9	17.667	17.333	34.93	36.73	34.5
L8*T2	18.4	17.5	17.2	41.97	40.63	35.97	16.567	17.4	16.8	**30.43**	36.13	33.23
L8*T3	18.4	17.633	17.433	38.83	36.23	32.47	16.267	16.833	16.6	31.03	38.07	33.6
L9*T1	16.7	16.333	15.9	37.07	35.17	31.67	16.733	17.867	17.467	35.63	43.33	41.9
L9*T2	16.5	**16.267**	15.933	37.03	34.43	29	17	17.867	17.467	32	39.17	36.63
L9*T3	16.567	16.467	16.6	**33**	**31.07**	**26.67**	15.933	16.467	15.933	31.77	39.27	35.27
L10*T1	16.633	16.4	16.033	34.6	32.3	28.47	18	18.7	18.367	38.63	46.57	44.87
L10*T2	**16.2**	15.6	**15.1**	35.53	33.17	28.73	17.333	18.733	17.667	39.17	44.4	41.03
L10*T3	17.7	17.2	16.567	36.87	35.67	32.13	16.967	18	17.433	34.47	38.07	38.4
G.M	**17.033**	**16.557**	**16.189**	**37.89**	**35.80**	**31.68**	16.456	17.259	16.686	**34.37**	**40.20**	**38.29**
L.S.D	**0.393**	**0.402**	**0.411**	**1.637**	**2.329**	**3.223**	0.428	0.365	0.401	**2.539**	**2.502**	**2.117**

Table 5: Means for 1000 kernel weight and grain yield for 31 maize genotypes that planted under three sowing dates during spring and autumn seasons of 2017

Line	**Spring**						**Autumn**					
	1000 kernel weight			**Grain yield**			**1000 kernel weight**			**Grain yield**		
	Date1	**Date2**	**Date3**	**Date1**	**Date2**	**Date3**	**Date1**	**Date2**	**Date3**	**Date1**	**Date2**	**Date3**
T1	196.33	189.67	187.67	171	142.67	112.33	189.33	203	195	123.7	200.3	157.67
T2	192.33	186	177.33	151	131.67	100.33	179.33	197.33	188.67	115.7	176	146.33
T3	182	173.67	165.33	113.3	95.67	86.33	167.67	186.67	**175**	100	135.7	110.67
L4	**203**	**197.33**	**191.67**	**187.3**	**151.67**	**122.33**	**195**	**211**	**200.67**	**128.7**	**211**	**171.67**
L5	188	181	175	133	113	99.67	176.67	193.67	183.33	113.3	158.3	125.33
L6	186	178.33	173	129	112.67	95.67	173.33	187	184.67	107.3	140	132.33
L7	**173.67**	**170.33**	**163.67**	**106.3**	**93.33**	**74**	**166.67**	**182.67**	176.67	**88.7**	**127.3**	**108.67**
L8	179.33	172	169	117	98	81.33	171	188.33	175.67	95	137.7	114.33
L9	184	176.33	169	119.7	104	84.33	170.33	194	182	95.3	141.3	120.67
L10	189	182.67	173.67	138.7	125.33	96	175.67	195	187.33	109	157.3	142.33
L4*T1	**288.67**	**283.67**	**276**	295.7	252	**204**	**278.33**	**293.33**	**281.67**	217.3	327.3	277
L4*T2	255.67	248	239	284.3	228	192	267	279	271.67	**225.3**	**349.7**	283.67
L4*T3	252.33	245	238.67	246	208.33	169.33	245.67	254.67	245.67	188	263.7	219.33
L5*T1	234.67	228.67	221.67	194	167.67	140	242.67	263.33	246.33	215	292.7	261
L5*T2	236.67	230.33	221.67	185.7	157.67	134	250.33	257	251.67	200	279.7	247.33
L5*T3	247.33	242	236.67	241	207	158.67	226.33	232	223	144	212.3	177.33
L6*T1	267	261	256.67	**307.7**	**267.33**	200.33	241.67	258.67	249	192.7	274	245.33
L6*T2	272	267.67	260	306.3	253.67	201.33	239	247.67	239	185	263.7	236.33
L6*T3	249.33	248.67	245.67	255.3	218.67	184	**213.67**	220	**216**	137.3	**189.7**	169.33
L7*T1	242.33	236	233.33	243.7	211.33	161.33	228	245.67	233.67	169.3	229.3	191.67
L7*T2	232	223.67	217.33	184	155.67	129.33	226	239	229	149	210	183.33
L7*T3	234	231.67	223.67	168.7	151.33	118	263.33	282	271.67	166.3	226	189.67
L8*T1	242	237.67	232	207.7	174.67	137	225	241.33	235.67	163.3	211.3	181.67
L8*T2	257.67	255.67	247.67	259.7	235	193.67	222	238.33	234.33	134.7	196.7	162.67
L8*T3	246.67	242	235.67	230	198.33	163	214.67	226	217.33	**130**	190	**151.67**
L9*T1	224	219	215.67	184.7	157	127	239.67	251.67	244	179.3	272.3	233
L9*T2	212	210.33	207.33	167.7	146.67	111.33	233.33	250	241.67	157	235.3	198
L9*T3	276.33	271.67	266.33	196.7	174.33	139.67	214	**216.67**	228	131	**189.7**	161.67
L10*T1	218.33	212.33	**204**	160.7	140	110.67	256.67	273	267.33	219	339	**303.67**
L10*T2	**210.33**	**208**	211	**160.3**	**132.33**	**108.67**	246	263.33	259	215.7	293.7	248.67
L10*T3	240	237.33	235.67	209.3	178.33	149	234.33	248	230.33	165	232.3	191.67
G.M	**226.23**	**220.89**	**215.19**	**195.3**	**167.20**	**134.99**	**218.47**	**232.88**	**224.68**	**153.6**	**221.4**	**188.39**
L.S.D	**6.813**	**4.699**	**5.602**	**18.34**	**13.027**	**14.816**	**10.386**	**9.182**	**7.311**	**15.77**	**24.03**	**14.590**

Table 6: Standard heterosis % for number of ears per plant and ear length in maize under three sowing dates at spring and autumn seasons of 2017

Hybrids	Spring						Autumn					
	Number of ears per plant			Ear length(cm)			Number of ears per plant			Ear length(cm)		
	Date1	Date2	Date3	date1	date2	date3	Date1	Date2	Date3	date1	date2	date3
L4*T1	-0.754	1.604	1.961	-1.820	11.925	-5.727	3.033	0.483	2.097	-1.975	-11.903	-6.348
L4*T2	2.759	6.024	5.028	-10.887	5.862	-7.813	1.102	-0.251	5.880	-1.145	2.041	-12.360
L4*T3	**-5.533**	0.822	**-1.953**	16.072	-7.633	0.523	4.417	-0.737	5.615	-0.393	**-13.944**	-0.387
L5*T1	2.267	2.406	7.410	1.322	18.159	-11.869	7.862	2.437	3.927	-1.213	**7.865**	-8.945
L5*T2	4.504	4.986	4.286	-10.887	0.874	-7.511	4.530	2.838	2.715	-2.273	-5.555	-6.802
L5*T3	8.065	7.286	7.120	**25.553**	-7.633	**-12.835**	2.261	5.157	4.648	**-92.634**	-2.151	-13.230
L6*T1	5.290	8.021	1.978	2.727	4.366	8.185	-0.284	**-4.880**	**-1.304**	-4.728	3.214	-1.924
L6*T2	5.037	7.205	1.132	-0.804	6.522	0.798	6.401	7.772	11.136	-9.076	-6.091	-10.187
L6*T3	5.059	3.639	2.256	-3.121	2.006	0.000	**-0.560**	3.886	5.467	1.087	-3.214	-5.921
L7*T1	3.023	7.748	7.410	6.032	4.525	9.238	7.298	0.973	2.882	-2.585	-1.171	0.409
L7*T2	**9.811**	**13.023**	**10.207**	-8.468	1.648	1.604	9.042	**10.881**	**13.858**	-6.642	-7.162	1.985
L7*T3	1.613	2.521	0.573	-0.433	-2.006	-4.688	2.822	4.920	4.918	-11.441	-6.989	-9.961
L8*T1	0.000	0.802	3.419	22.224	**18.621**	**9.316**	3.649	-1.463	1.312	-2.783	-3.431	**12.027**
L8*T2	2.083	7.479	9.538	-8.867	14.785	-7.846	1.399	0.252	1.353	-2.432	-0.734	2.765
L8*T3	2.350	7.840	4.556	-12.821	2.813	-10.787	1.399	0.252	2.459	5.009	-5.585	-9.629
L9*T1	0.506	0.000	0.000	-6.853	-3.954	5.019	5.612	2.437	2.356	-11.164	-2.815	-5.921
L9*T2	3.183	3.324	1.749	4.440	-2.769	8.794	6.310	4.945	4.345	-19.272	-3.872	-9.629
L9*T3	4.839	5.605	1.137	-12.901	-7.512	-7.813	3.110	5.455	3.279	-10.303	-10.912	-12.175
L10*T1	-3.521	0.000	1.427	-2.679	5.287	3.679	3.371	4.390	8.380	2.745	-3.764	**-13.699**
L10*T2	5.300	1.093	2.586	**-15.321**	**-8.128**	5.787	**9.909**	4.418	6.144	4.139	2.855	-6.358
L10*T3	6.366	0.542	1.427	9.824	3.614	5.211	2.261	6.499	-0.273	**7.733**	-3.065	-7.748
SE	**0.034**	**0.028**	**0.022**	**0.638**	**0.711**	**0.631**	**0.024**	**0.037**	**0.028**	**0.743**	**0.762**	**0.953**

Table 7: Standard heterosis % for number of rows per ear and number of kernels per row in maize under three sowing dates at spring and autumn seasons of 2017

Hybrids	Spring						Autumn					
	Number of rows per ear			Number of kernels per row			Number of rows per ear			Number of kernels per row		
	Date1	Date2	Date3	date1	date2	date3	Date1	Date2	Date3	date1	date2	date3
L4*T1	1.390	-0.201	1.048	10.120	11.149	12.437	0.414	1.179	0.404	6.488	9.217	9.510
L4*T2	11.725	5.689	8.373	4.988	6.741	10.856	5.759	10.803	5.223	**14.501**	**13.525**	9.341
L4*T3	11.529	11.177	9.628	0.169	-1.400	3.579	9.056	10.214	7.633	4.112	-5.230	-8.448
L5*T1	4.442	3.742	1.690	-11.036	-8.092	-3.700	8.750	**17.464**	8.228	12.946	-2.778	**19.774**
L5*T2	7.160	7.547	7.676	-10.946	-14.324	-7.805	10.991	12.626	9.938	5.573	4.474	12.137
L5*T3	12.050	10.468	8.770	12.469	10.606	1.155	6.091	5.613	7.776	-7.847	0.938	2.102
L6*T1	12.527	13.310	12.658	11.788	11.445	12.149	10.419	12.377	**13.580**	9.689	0.394	11.723
L6*T2	14.926	9.642	8.533	**18.765**	13.865	**20.570**	5.492	11.826	10.354	3.412	-1.268	3.893
L6*T3	**20.689**	**15.755**	14.126	16.383	**16.178**	16.295	5.369	6.127	6.480	-0.302	3.569	-1.855
L7*T1	12.121	9.774	3.797	0.075	0.692	3.515	1.669	4.389	4.117	4.364	-10.116	-2.701
L7*T2	2.656	2.516	1.919	-10.347	**-15.135**	-5.918	2.746	1.202	3.106	-10.350	-12.512	-12.214
L7*T3	11.961	10.175	7.503	1.216	4.730	-6.757	9.352	5.239	7.776	-6.169	-0.365	-2.381
L8*T1	7.273	7.485	6.120	-8.202	-9.768	-10.268	5.625	5.790	6.994	1.629	**-14.977**	-9.520
L8*T2	12.883	10.063	10.024	9.382	9.811	13.829	5.074	4.611	4.348	**-13.477**	-13.565	**-15.445**
L8*T3	20.521	14.746	**14.940**	15.910	15.862	9.696	6.091	5.868	7.562	-6.169	5.956	-0.797
L9*T1	1.212	1.871	0.633	-7.023	-6.388	-2.344	4.581	6.988	7.821	3.666	0.301	9.887
L9*T2	1.227	2.308	1.919	-3.492	-6.946	-8.228	7.820	7.419	8.491	-9.013	-6.292	-6.794
L9*T3	8.515	8.101	8.263	-6.436	-6.218	-9.899	3.913	3.566	3.240	-3.931	5.366	-1.946
L10*T1	0.806	1.863	1.475	**-13.218**	-14.027	**-12.211**	**12.500**	13.795	12.453	12.395	7.801	17.676
L10*T2	**-0.613**	**-3.106**	**-3.409**	-7.402	-10.351	-9.082	9.932	12.626	8.168	11.373	6.220	4.402
L10*T3	9.482	6.832	8.048	2.048	1.914	3.080	8.533	9.536	6.735	4.233	-0.523	3.143
SE	**0.196**	**0.201**	**0.205**	**0.819**	**1.164**	**1.611**	**0.214**	**0.182**	**0.200**	**1.269**	**1.251**	**1.058**

Table 8: Standard heterosis % for 1000 kernel weight and grain yield in maize at spring and autumn seasons of 2017

Hybrids	Spring						Autumn					
	1000 kernel weight			Grain yield			1000 kernel weight			Grain yield		
	Date1	Date2	Date3	Date1	Date2	Date3	Date1	Date2	Date3	Date1	Date2	Date3
L4*T1	42.202	43.754	43.997	57.875	66.150	66.762	42.733	39.019	40.365	68.842	55.118	61.356
L4*T2	25.946	25.678	24.693	51.789	50.326	56.953	36.923	32.227	35.381	75.058	65.735	65.241
L4*T3	24.300	24.158	24.521	31.340	37.357	38.421	25.985	20.697	22.425	46.076	24.976	27.763
L5*T1	19.528	20.562	18.117	13.450	17.523	24.633	28.173	29.719	26.323	73.808	46.131	65.536
L5*T2	23.054	23.833	25.004	22.980	19.746	33.559	39.592	30.239	33.392	72.861	58.920	69.022

L5*T3	31.559	33.702	35.240	81.203	83.186	59.195	28.109	19.791	21.639	27.096	34.112	41.490
L6*T1	35.996	37.607	36.767	79.942	87.376	78.341	27.645	27.424	27.692	55.780	36.795	55.597
L6*T2	41.424	43.909	46.619	**102.848**	92.656	**100.668**	33.274	25.511	26.676	59.896	49.830	61.505
L6*T3	34.048	39.444	42.006	97.907	94.080	92.328	23.274	17.647	16.965	27.959	35.500	27.960
L7*T1	23.430	24.427	24.330	42.515	48.125	43.621	20.425	21.020	19.831	36.863	14.478	21.564
L7*T2	20.626	20.253	22.557	21.854	18.227	28.905	26.025	21.117	21.376	28.781	19.318	25.285
L7*T3	28.571	33.397	35.287	48.897	57.685	36.685	**57.053**	**51.069**	**53.773**	66.300	66.544	71.383
L8*T1	23.262	25.307	23.621	21.462	22.429	21.962	18.840	18.882	20.856	32.013	5.492	15.222
L8*T2	33.973	37.457	39.666	71.987	78.476	93.033	23.794	20.777	24.201	16.422	11.761	11.167
L8*T3	35.533	39.345	39.450	96.581	**102.378**	88.810	25.538	20.002	23.715	30.000	37.981	32.660
L9*T1	14.094	15.464	14.920	8.012	10.044	13.060	26.588	23.975	25.128	44.947	35.946	47.777
L9*T2	10.227	13.081	16.918	11.060	11.392	10.964	30.112	26.691	28.091	35.696	33.693	35.311
L9*T3	**50.179**	**54.069**	**57.592**	64.327	67.625	61.786	25.638	11.686	25.275	31.000	34.253	33.977
L10*T1	11.206	11.947	8.701	**-6.023**	**-1.871**	**-1.478**	35.568	34.483	37.092	77.041	**69.246**	**92.598**
L10*T2	9.359	11.828	18.987	6.159	0.501	8.313	37.177	33.447	37.277	**86.430**	66.875	69.938
L10*T3	26.984	29.923	35.700	50.901	42.288	55.208	33.392	27.179	22.954	51.376	47.680	34.666
SE	**3.406**	**2.349**	**2.801**	**9.169**	**6.513**	**7.407**	**5.192**	**4.591**	**3.655**	**7.882**	**12.011**	**7.294**