Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 13(2), 309-325, 2005

GENETIC PARAMETERS OF SOME AGRONOMIC TRAITS IN YELLOW MAIZE UNDER TWO PLANTING DATES

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ABSTRACT

Six population's seeds of four yellow maize crosses were formed during 2001 and 2002 growing seasons. Their plants were evaluated during 2003 growing season under two planting dates (14th May and 29th June) for six agronomic traits at the Agric. Res. Stat. of Fac. of Agric., Ain Shams Univ., Shalakan, Kalubia Governorate, Egypt. The present work aimed to determine the genetic parameters and their interactions with planting dates for grain yield per plant, 100-kernel weight, number of kernels per row, ear length, ear diameter, and days to silking in the six populations (P_1, P_2, F_1, F_2, BC_1 and BC_2). Mean values of the six populations for all studied traits in all crosses were higher under normal planting date than those under late one. Therefore, normal planting date seemed to be non-stress environment. The potence ratio for all traits in the four crosses exceeded (+1) except days to silking where it was less (-1). The highest heterosis percentage relative to mid and better parent reached 192.06% and 152.01% in cross 1 for grain yield per plant under late planting date. Inbreeding depression values were not-significant in all studied traits except ear diameter and 100-kernel weight in crosses 1 and 3 as well as grain yield per plant in all crosses also, it was positive for most studied characters in the four crosses except days to silking trait. Dominance occupied the first rank, additive or dominance type of epistasis occupied the second or the third contributor to the genetic effects in order of importance according to cross with exception of days to silking, where additive and additive occupied the first and the second ranks. Narrow sense heritability was relatively high for yield attributes whereas it was low for grain yield per plant. Meantime, expected genetic advance was relatively moderate or low for all traits. Therefore, it could be suggested that selection for most studied traits in the subsequent generations will be relatively more effective than in the early generations.

Key words: Maize, Planting date, Potence ratio, Heterosis, Inbreeding depression, Heritability, Genetic advance and Gene action.

INTRODUCTION

Maize is one of Egypt's principal cereal crops. It is used as feed for livestock and poultry. In Egypt, it is planted successfully under irrigation from mid-April to mid-August, although most of the area is planted between mid May to mid June

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(Received November 2, 2004)
(Accepted November 29, 2004)

as optimum period for production, whereas yield of grain decreases after that date. In this respect, **El-Hosary *et al* (1990a & b) and Eraky *et al* (2003)** reported that in most cases mean values of grain yield and its components were higher under normal planting date compared with those under late planting date.
Testing the genetic materials under different environments is valuable to select the high yielding genotypes of maize. Both heterosis and inbreeding depression share a similar phenomenon, therefore its logic to predict that heterosis in the F_1 well be followed by an appreciable reduction in F_2 performance. **Yassien (1999a and b) and Amer & Mosa (2004)** found that the highest heterosis values relative to mid and better parent were obtained for grain yield per plant compared to other traits. On the other hand, **Yassien (1999a & b)** reported that inbreeding depression was positive and not significant in grain yield and its components while, **Amer and Mosa (2004)** reported that inbreeding depression was significant for grain yield and its components with exception of number of rows per ear.

Generation mean analysis (GMA) is important to determine the gene action controlling grain yield and its components to develop appropriate breeding procedures. Several models have been developed for analysis of generation means **(Hayman 1958 and Vandeer Veen 1959).** These models provide information about epistasis besides estimation of additive and dominance variances and their effects. Also, these models evaluate parents, these information's are very important for the breeder in making decisions for the allocation of resources and expected response to selection. **Gonzalez and Dudley (1981)** used P_1, P_2, F_1, F_2, F_3, F_4, BC_1 and BC_2 of 15 F_1 crosses from six inbred lines to estimate genetic parameters in maize and mentioned that the dominance effects were the most important genetic effects controlling the expression of grain yield per plant, ear length and ear diameter. Also, they noted that dominance X dominance effects were consistently negative for all traits except grain yield, whereas dominance effects for yield were larger than additive ones. **Johanson *et al* (1955)** reported that heritability estimates along with genetic gain are usually more useful than the heritability values alone in predicting the resultant effect for selecting the best individuals. On the other hand, high heritability is not always associated with high genetic advance, but to make effective selection high heritability should be associated with high genetic gain. **Barakat (2003)** found that heritability values were 61.4% for grain yield per plant and 63.2% for days to silking. The expected genetic advance was 7.97 and 11.18 for the same traits. The main objectives of the present study were to determine the optimum planting date for evaluation and suitable planting date for selection of the studied traits. Also, to determine the potence ratio, heterosis and inbreeding depression as well as types of gene action, heritability and predicted genetic advance for all studied traits.

MATERIAL AND METHODS

Six inbred lines of yellow maize were used in this study. Three of them namely; CML.326 (P_1), CML.325 (P_2) and CML.134 (P_3) were introduced from CIMMYT. The remaining three inbred lines, viz. CM.202 (P_4), Roh.43Ht,B (P_5) and BS-10-8 (P_6) were kindly provided by the Maize Research Department, Field Crops Research Institute, Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Giza, Egypt. The six parental lines were crossed in a half diallel fashion in 2001 season. In 2002 season, parents and the F_1's seeds were planted and at flowering time some of the F_1 plants were selfed and others crossed to their parents to obtain F_2, BC_1 and BC_2 seed. On the basis of the results from previous diallel trail in 2002 season the four crosses, i.e., CML.134 X BS-10-8 (cross 1), CM.202 X Roh.43Ht,B (cross 2), CML.326 X CML.325 (cross 3) and CML.326 X BS-10-8 (cross 4), which showed good yield and other agronomic characteristics, were selected for Generation mean analysis (GMA) study. The six populations i.e. P_1, P_2, F_1, F_2, BC_1 and BC_2 of each of the four crosses were grown in separate experiments under the two planting dates (14^{th} May and 29^{th} June). Each experiment was arranged in a Randomized Complete Block Design with four replicates. Each replication consisted of 13 ridges of F_2 plants, 7 ridges for both BC_1 and BC_2 and 4 ridges for each of P_1, P_2 and F_1 populations. Each ridge included 16 single plants, 25 cm apart within ridges of 70 cm width. All agricultural practices were applied as recommended. Data were recorded on 80 guarded plants for each of P_1, P_2 and F_1 population, 484 plants for F_2 and 245 plants for each of BC_1 and BC_2 populations for grain yield per plant, 100-kernel weight, number of kernels/ row, ear diameter, ear length and days to silking. Data were statistically analyzed according to **Snedecor and Cochran (1981).** Differences were tested against the least significant difference at 0.05 and 0.01 levels of probability. The means and variances were calculated for each population. The potence ratio was calculated as indicated by **Smith (1952).** Inbreeding depression and heterosis as the deviation of F_1 generation from the mid-parent (MP) and better parent (BP) were calculated as described by **Singh and Chaudhary (1977).** Gene action was tested using the means of the six populations in each cross to estimate the six parameters for gene effects, using the equations illustrated by **Hayman (1958) and Jinks and Jones (1958).** The type of gene action; complementary or duplicate, was assessed based on the sign of h and l gene effects i.e. complementary (Com.) = same sign and duplicate (Dupl.) = opposite signs. Broad (BSH) and narrow (NSH) sense heritabilities were estimated according to **Burton (1951) and Warner (1952)** for all studied characters. Genetic advance as percentage of F_2 mean (ΔG %) was estimated at 5% intensity of selection outlined by **Allard (1960).**

RESULTS AND DISCUSSION

Means and variances of the six populations for the studied characters in the four crosses are shown in Table (1). Significant differences between the two planting dates for all traits in the four crosses except cross 3 for days to silking and ear length, crosses 2, 3 and 4 for ear diameter, cross 1 for number of kernels per row and cross 3 for 100-kernel weight, indicating that these hybrids behaved somewhat differently from one planting date to another These results are in harmony with those obtained by **El-Hosary *et al* (1990 a and b); Eraky *et al* (2003) and Soliman *et al* (2004).** Highly significant differences were shown

among the six populations in each cross for all traits, meaning that the populations within each cross were genetically different from each other for all characters. Population variance of F_2's had the highest values for all studied traits in the four crosses. In general, results indicated that segregating generations (BC_1, BC_2 and F_2) had higher variances than the non-segregating generations (P_1, P_2 and F_1) for all traits.

Our results are in harmony with those obtained by **Awaad & Hassan (1997); El-Hosary & Abd El-Sattar (1998)**; **Yassien (1999a & b); Khalil (1999) and Amer & Mosa (2004).** The mean performance values of different populations for most studied traits at normal planting date being higher than the corresponding ones at the late one. This result is supported by those concluded by **El Hosary *et al* (1990a) and Eraky *et al* (2003).**

Estimates of potence ratio, heterotic effects and inbreeding depression for all traits are shown in Table (2). In most cases, the potence ratios for all traits in the four crosses exceeded (+1) except days to silking where it was less (-1) indicating that over dominance towards the earlier parent for silking while, it was towards the higher parent in the other traits. Similar results were found by **El- Hosary & Abd El-Sattar (1998) and Edwards & Lamkey (2002).** For all the studied characters in the four crosses heterosis values as deviation percentage of F_1 from the mid and better parents were positive except days to silking indicating that dominance and / or over dominance could be effective in the inheritance of most attributes. In most cases, heterotic effects were significant and highly significant relative to mid and better parent for most studied traits in the four crosses under the two planting dates. The highest heterosis percentage relative to mid and better parent under normal planting date reached 189.12% and 139.37% in cross 3 for grain yield per plant while the lowest ones reached -15.57% in cross 2 and -12.72% in cross 4 for days to silking. On the other hand, the highest heterosis percentage relative to mid and better parent under late planting date reached 192.06% and 152.01% in cross 1 for grain yield per plant while the lowest ones reached -18.27% and -14.03% in cross 2 for days to silking. In this respect, **Amer and Mosa (2004)** found similar results considering to days to silking while, our estimates of heterosis percentage were higher than those obtained by **Khalil (1999)** and smaller than those obtained by **Awaad and Hassan (1997).** Inbreeding depression values were not-significant in most traits except ear diameter, 100-kernel weight and grain yield per plant and it was positive for most studied characters in the four crosses except days to silking trait. The positive inbreeding depression indicated that dominance played an important role for these traits and consequently manifestation of heterosis can not be maintained in the segregating generations. However, both heterosis and inbreeding depression are coincided to the same particular phenomenon therefore, it is logical to predict that heterosis in the F_1 well be followed by an appreciable reduction in F_2 performance. Our results are in harmony with **Awaad & Hassan (1997); El-Hosary & Abd El-Sattar (1998); Khalil (1999); Yassien (1999 a & b); Abd El-Aty & Katta (2002) and Amer & Mosa (2004).**

Nature of gene action was computed according to **Hayman (1958) and Jinks**

& Jones (1958) and the obtained values are presented in Tables (3, 4 and 5). The significance of any one of scales (A, B, C and D) is taken to indicate the presence of non-allelic interaction. The four crosses exhibited highly significant mean effects (m) for all traits under the two planting dates. Dominance occupied first rank in all characters with duplicate type of epistasis except days to silking in the four crosses under the two planting dates, indicating the possibility of obtaining transgressive segregates in later generations. Either additive (i) or dominance (l) type of epistasis was the second or the third contributor to the genetic effects according to cross. In this case selection had to be postponed to advanced generations for the realization of superior segregate. Similar findings were obtained by **El- Hosary and Abd El-Sattar (1998); Khalil (1999); Yassien (1999a); Mosa (2003); Shafey *et al* (2003); El-Beially (2003) and Amer & Mosa (2004)**. For days to silking, additive (i) and additive (d) occupied the first and the second ranks, respectively followed by dominance (l) type of epistasis with complementary type of epistasis suggesting a recurrent selection technique for improving this character in crosses 1, 2 and 4 while additive (i) and dominance (l) gene interactions with duplicate type of epistasis were predominant in cross 3 under normal planting date, indicating the possibility of obtaining transgressive segregation in later generations for this cross. In this respect, most investigators **(El-Zeir *et al* 1993 and El-Beially, 2003)** mentioned that the additive gene effects were found to be larger than dominance effects for days to silking**. El-Rouby *et al* (1973)** reported that the additive effects were predominant in the early planting date but dominance gene effects were important in the late one.

Heritability values in narrow sense (HNS) and expected genetic advance values as percentage of F_2 mean (Δg %) for all traits are shown in Table (6).

Heritability values in broad sense were higher than those of narrow sense for the studied characters in all crosses. In most cases narrow sense heritability values were relatively high or moderate for yield attributes and days to silking while the expected genetic advance values were relatively moderate or low for all traits. Therefore, it can be exploited efficiently through recurrent selection to make up all studied traits except days to silking where suggesting the importance of phenotypic selection for improving population mean based on, intensity of selection would be relatively moderate as well as progeny test of selected plants. Our data are supported by the results of **El Rouby *et al* (1973), Awaad and Hassan (1997), Khalil (1999), Yassien (1999b) and Guzman and Lamkey (2000).** Finally, from all the previous results it can be briefly concluded that:

The values of different genetic parameters under the study were higher at normal planting date than those at late one for all traits with exception of heritability in narrow sense for ear height, genetic advance percentage for plant height, potence ratio for each of ear length, ear height and days to silking and heterosis percentage for grain yield per plant, ear diameter and days to silking where their values were higher under late planting date compared with those under normal one.

On the other hand, no trend was observed for HNS for ear diameter and ear length, ΔG % for number of kernels per

Table 6. Heritability estimates in broad and narrow sense (HBS & HNS) and expected genetic advance (ΔG %) for studied traits in the four yellow maize crosses under the two planting dates

Crosses	Genetic parameters	planting date	Days to Silking	Ear length	Ear diameter	No. of kernels/ row	100-kernel weight	grain yield/ plant
1	HBS	D_1	87.00	76.69	83.00	76.09	93.04	88.18
(P_3 X P_6)		D_2	89.29	71.20	76.87	73.19	91.65	87.23
	HNS	D_1	77.00	59.45	36.02	55.39	57.25	23.00
		D_2	53.07	62.49	60.29	27.32	43.41	20.38
	(ΔG %)	D_1	8.36	17.52	7.26	26.85	21.66	17.21
		D_2	6.67	17.59	12.71	14.09	20.15	14.26
2	HBS	D_1	78.00	77.02	70.05	77.00	95.28	85.87
(P_4 X P_5)		D_2	87.14	59.94	65.05	73.59	77.26	85.57
	HNS	D_1	62.00	51.78	30.43	20.30	57.00	37.00
		D_2	56.26	45.68	41.21	49.70	49.48	27.02
	(ΔG %)	D_1	6.07	16.49	8.24	9.70	29.20	17.11
		D_2	8.11	13.22	9.49	26.38	16.09	21.83
3	HBS	D_1	89.00	82.15	70.43	86.47	90.00	87.00
(P_1 X P_2)		D_2	84.49	77.86	62.13	70.23	73.92	67.04
	HNS	D_1	63.00	43.00	48.59	51.49	53.00	33.00
		D_2	65.42	42.86	39.20	45.85	40.03	31.42
	(ΔG %)	D_1	8.05	15.31	9.49	25.37	19.25	15.88
		D_2	8.80	15.19	6.60	22.79	15.36	17.66
4	HBS	D_1	93.90	76.21	78.17	75.75	91.90	93.90
(P_1 X P_6)		D_2	81.21	61.42	65.63	59.50	69.41	82.98
	HNS	D_1	77.00	42.00	60.00	34.00	51.00	19.00
		D_2	63.50	32.72	42.50	30.33	35.01	21.92
	(ΔG %)	D_1	9.04	12.66	11.48	15.31	19.73	16.74
		D_2	6.51	9.67	8.20	15.36	13.95	12.27

row, ear diameter and days to silking. The normal planting date is considered as an optimum environment for evaluation all studied traits while the late planting date is more suitable environment for obtaining more variation for most traits. In most cases, selection would be effective in advanced generations for improving the most studied traits.

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مجلة اتحاد الجامعات العربية للدراسات والبحوث الزراعية، جامعة عين شمس، القاهرة ، 13(2)، 309-325، 2005

الثوابت الوراثية لبعض الصفات المحصولية في الذرة الصفراء تحت ميعادين للزراعة

[19]

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أجريت هذه الدراسة بمحطة التجارب والبحوث الزراعية – كلية الزراعة – جامعة عين شمس – بشلقان – محافظة القليوبية خلال الموسم الصيفي لأعوام 2001، 2002، 2003 وذلك بهدف دراسة تأثير ميعادين للزراعة (العادي والمتأخر) على بعض الصفات النباتية والمحصولية وعلى تقديرات بعض الثوابت الوراثية مثل قوة الهجين ومعامل التوريث بمعناه الواسع والضيق ومقدار التقدم الوراثي المتوقع ودراسة طبيعة الفعل الجيني وتعبيره وكذلك دليل أو درجة السيادة والنقص المتوقع نتيجة التربية الداخلية. استخدمت في هذه الدراسة ست سلالات نقية من الذرة الصفراء الشامية منها ثلاث سلالات CML.326 (P_1) CML.325, (P_2) وCML.134 (P_3) مستوردة من مركز تحسين الذرة والقمح بالمكسيك والأخرى محلية CM.202 (P_4) و (P_5) Roh.43Ht,b وBS-10-8 (P_6). تم عمل دائرة تهجينات تبادلية بينها (في إتجاه واحد) في موسم 2001 وفي موسم 2002 زرعت الآباء والـ F_1 بهدف الإكثار الذاتي والتهجينات المختلفة للحصول على بذرة الجيل الثاني F_2 والجيلين الرجعيين BC_1 وBC_2 وكذلك المحافظة على بذور الجيل الأول F_1 والأبويين P_2 X P_1. وبناءً على نتائج تحليل البيانات المتحصل عليها من الهجن الفردية في موسم 2002 أمكن إنتخاب أربعة هجن فردية هي: الهجين الأول (P_3 X P_6) والهجين الثاني (P_5 X P_4) والهجين الثالث(P_1 X P_2) والهجين الرابع (P_1 X P_6) حيث زرعت حبوب العشائر الستة لكل هجين في الموسم 2003 تحت ميعاديين للزراعة عادي في 14 مايو ومتأخر في 29 يونيو (تجربة لكل ميعاد) وزرعت كل تجربة بتصميم القطاعات كاملة العشوائية في أربع مكررات. وقد أجريت جميع العمليات الزراعية المعتادة في زراعات الذرة الشامية من ري ومقاومة الحشائش والحشرات وخلافة حتى نضج النباتات. تم أخذ القراءات والقياسات على 80 نبات محاط لكل من التراكيب الوراثية الأبوية والجيل الأول

و245 نبات لكل من الجيلين الرجعيين و484 نبات من الجيل الثاني لصفات عدد الأيام من الزراعة حتى ظهور الحريرة (مياسم النورة المؤنثة)، طول الكوز بالسم، قطر الكوز بالسم، عدد الحبوب بالصف، وزن المائة حبة بالجم وأنتاجية النبات من الحبوب بالجم. وبعد تحليل البيانات المتحصل عليها أحصائياً ووراثياً لكل ميعاد زراعي على حده.

يمكن تلخيص النتائج المتحصل عليها على النحو الآتي

1- أظهرت نتائج تحليل التباين أن هناك فروق معنوية بين متوسطات ميعادي الزراعة لكل الصفات تحت الدراسة للهجن الأربعة بإستثناء الهجين الثالث في صفة عدد الأيام من الزراعة حتى ظهور الحريرة وصفة طول الكوز وكذلك الهجين الثاني والثالث والرابع في صفة قطر الكوز والهجين الأول في صفة عدد الحبوب بالصف والهجين الثالث في صفة وزن الـ 100 حبة.

2- كانت القيم المعبرة عن سلوك العشائر الستة لكل هجين عالية في ميعاد الزراعة العادي مقارنة بتلك تحت ميعاد الزراعة المتأخر مما يدل على أن ميعاد الزراعة العادي يمثل بيئة مناسبة وغير مجهدة لتقييم التراكيب الوراثية لتلك الصفات حيث يتوفر في ميعاد الزراعة العادي حرارة مناسبة وإضاءة شمسية كافية ملائمة للنمو الخضري لنباتات الذرة الشامية.

3- كانت قيم قوة الهجين عالية المعنوية في كل الهجن تحت الدراسة في ميعادي الزراعة. وكانت أعلى هذه القيم بالنسبة لمتوسط الأبوين والأب الأفضل على التوالي سالبة في ميعاد الزراعة العادي في صفة عدد الأيام من الزراعة وحتى ظهور الحريرة بينما كانت موجبة في الصفات الأخرى وكانت أعلى القيم 192.06% و152.01% بالنسبة لصفة أنتاجية النبات من الحبوب في الهجين الأول تحت ميعاد الزراعه المتأخر.

4- تخطت درجة السيادة +1 في كل الصفات تحت ميعادي الزراعه عدا صفة عدد الأيام من الزراعة حتى ظهور الحريرة حيث كانت درجة السيادة أقل من -1 وهذا يشير إلى أن السيادة الفائقة تتجه نحو الأب المبكر في صفة التزهير بينما تتجه نحو الأب الأعلى في الصفات الأخرى.

5- إن قوة الهجين والتدهور الناتج عن التربية الداخلية تمثلان ظاهرتين متلازمتين لذلك كان من المنطقي أن نلاحظ حدوث تدهور في الجيل الثاني إلا أن هذا التدهور كان غير معنوياً في معظم الصفات عدا صفة إرتفاع النبات وقطر الكوز ووزن الـ 100 حبة وإنتاجية النبات من الحبوب كما كانت قيم التدهور موجبة قي كل الصفات عدا صفة عدد الأيام من الزراعة وحتى ظهور الحريرة.

6- أظهرت الهجن الأربعة تحت الدراسة قيماً عالية المعنوية لمتوسطات الجيل الثاني F_2 (m) تحت ميعادي الزراعة.

7- أحتل الفعل الجيني السيادي المرتبة الأولى من حيث أهميته في التحكم في وراثة كل الصفات تحت الدراسة عدا صفتي عدد الأيام من الزراعة وحتى ظهور الحريرة وصفة عدد الصفوف بالكوز، يليه في المرتبة الثانية أو الثالثة كل من الفعل الجيني المتفوق من النوع مضيف × مضيف (i) أو النوع سيادي × سيادي (l). ومن حيث الأهمية أحتل الفعل الجيني المضيف (d) والسيادي (h) المرتبة الأولى والثانية في صفة عدد الصفوف بالكوز بينما سيطر الفعل الجيني المتفوق من النوع مضيف × مضيف (i) والفعل الجيني المضيف (d) على المرتبة الأولى والثانية يليهما الفعل الجيني المتفوق من النوع سيادي × سيادي (l) في المرتبة الثالثة من حيث الأهمية في التحكم في وراثة صفة عدد الأيام من الزراعة وحتى ظهور الحريرة.

8- كانت قيم المكافىء الوراثي بمعناه الواسع تحت ميعادي الزراعة العادي والمتأخر مرتفعة نسبياً لكل الصفات تحت الدراسة بينما كانت قيم المكافىء الوراثي بمعناه الدقيق مرتفعة أو متوسطة نسبياً لمكونات المحصول في حين كانت منخفضة في صفة محصول النبات الفردي وتوافق ذلك مع قيم التقدم الوراثي المتوقع والتي كانت متوسطة نسبياً أو منخفضة. لذلك نستنتج أن الإنتخاب سيكون أكثر كفاءة في الأجيال المتأخرة حيث تكون هناك فرصة لحدوث أنعزالات متجاوزة الحدود.

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