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ORIGINAL ARTICLES

Genetic Analysis of Energy Production in White Maize Hybrids Cultivated In Newly Cultivated Sandy Land

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ABSTRACT

Two field experiments were carried out in newly cultivated sandy land at New Salheyia Region, Sharkia Governorate in summer seasons of 2009 and 2009 on eleven white maize hybrids to study genetic analysis of energy production white maize hybrids cultivated in newly cultivated sandy land.
Results can be summarized as follows:

1- White maize hybrids significantly differed in growth characters at the different stages of growth, as well as, in yield and its components.
2- The eleven white maize hybrids differed significantly in photosynthate partitioning, where, significant differences were found in carbohydrate percentage in vegetative organs, kernels and straw, in protein % in straw and oil %in kernels. Moreover, glucose required for synthesis of different chemical constituents of each vegetative organs (except carbohydrate), kernels and straw, as well as, carbon equivalent was significantly differed between the eleven white maize hybrids under study (except for carbohydrate in vegetative organs). Furthermore, hybrid differences in yield energy per plant and/or fed. for kernels and straw yields, as well as, for the above ground biomass and coefficient energy of crop index and harvest index were significant
3- Highly significant correlation was found between kernels yield/plant and each of ear diameter, ear length, ears dry wt. /plant, No. of rows/ear, No. of kernels/row, RPP_{kr}, flag leaf blade area, 4^{th} leaf blade area, blades area/plant and LAI.
4- Ear diameter, flag leaf blade area, No. of ears/plant, No. of kernels/row, LAI and ear length could contribute much of white maize hybrids since R^2 was 100% of the variation.
5- Harvest white maize yield can be increase by growing single hybrids (S.C. 10, S.C. 124, S.C. 123 and S.C. 122) and the three way hybrids (T.W. 324 and T.W. 321), where these hybrids characterized by the highest value from vegetative growth, yield and its components, as well as, photosynthetic partitioning towards the economic yield compared with the other five white maize hybrids under study.

Key words: *Genetic Analysis,White Maize Hybrids, Sandy Land*

Introduction

The introduction of the white single crosses (i.e. S.C. 9, S.C. 10, S.C. 11, S.C. 12, S.C. 13, S.C. 14, S.C. 15, S.C. 122, S.C. 123, S.C. 124 and S.C. 129) and the three way crosses (i.e. T.W. 310, T.W. 311, T.W. 320, T.W. 321, T.W. 322, T.W. 324, T.W. 325, T.W. 326 and T.W. 327) of white maize hybrids, has resulted in an increased yielding ability when growing under modern production techniques. The yield potential of white maize plant can be defined as the total biomass produced or the agricultural important part of the corn (i.e. Kernels yield). The total biomass is a result of the integration of metabolic reaction of the plant. Consequently, any factor influencing the metabolic activity of the plant at any period of its growth can affect the yield. Metabolic processes in white maize plant are greatly governed by both internal, i.e. genetic make up of the plant and external conditions which involve two main factors namely climatic and edaphic environmental factors.

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Yield potential of white maize could be regulated through alternation of genetically make up and reconstitution of genetically structure through breeding program and/or by modification of environmental through improving cultural treatments. However Egyptian white maize cultivars may differ in their assimilating capacity and distribution could be referred as Source and Sink relation.

The objective of this study is to investigate genetic analysis of energy production in eleven white maize (*Zea maize* L.) hybrids cultivated in newly cultivate land. In this study, the growth and development of the plant was studied at fifteen days intervals starting from 65 up to 95 days after sowing to determine how the yield components developed. It is hoped that through our results, area of possible improvement may be shown which could help plant breeder in the development of future higher yielding white maize cultivar under newly cultivated lands conditions.

Material and Methods

White maize hybrids, i.e. the six single crosses (S.C. 10, S.C. 122, S.C. 123, S.C. 124, S.C. Pioneer 30k8 and S.C. Wataneia -4) and the five three way crosses (T.W. 321, T.W. 323, T.W. 324, T.W. Wataneia -1and Pioneer 3057) were cultivated in two field experiments in newly cultivated sandy land at New Salheyia Region, Sharkia Governorate in summer seasons of 2008 and 2009 to study genetic analysis of energy production in white maize in a complete randomized bloc design with six replication. Three replications were adapted for vegetative growth studies and the rest for yield and its components. Plot size was seven ridges, five meters long and 60cm apart. Planting was done at 26th May in the two seasons in hills spaced 25cm along, three kernels per hill. Thinning to one plant per hill was done at 21 days after planting. Nitrogen fertilizer was applied at a rate of 120 kg N/fed. in three equal doses at 21, 28 and 35 days after planting before irrigation. Irrigation, pest control, and other cultural practices were carried out as recommended.

Sample of five guarded plants were taken at random for growth measurements and chemical analysis at 65, 80 and 95 days from planting. The following growth attributes were recorded: plant height, number of active (green leaves)/plant, number of ears/plant, stem + sheets; blades and ears dry weight/plant. Furthermore, flag leaf; 4th leaf and blades areas cm^2/plant were calculated according to Bremner and Taha (1966), where, leaf area index (LAI) as Watson (1952). In addition, flag leaf and 4th leaf angles were recorded according to Pendelton *et al* (1968) between the leaf and stem.

At harvest, ten guarded plants were taken at random from the middle two ridges of each plot to determine yield attributes, plant height “cm”, stem diameter “cm”, number of ears/plant, ears dry weight “g/plant”, ear diameter “cm”, ear length “cm”, number of rows/ear, number of kernels/row, kernels and straw per plant and/or fed and above ground biomass (biological) yields per feddan.

Relative photosynthetic potential (RPP) for biological, and kernels yields and vegetative organs was calculated according to the methods described by Vidovic and Pokorny (1973), where $RPP_{kr} = y_{kr}$ per plant/LAI, $RPP_{bio} = y_{bio}$ per plant/LAI and $RPP_{veg} = RPP_{bio} - RPP_{kr}$.

In addition, kernels, straw and biological yields were determined from the other three middle ridges for each plot, where crop index, harvest index and migration coefficient were calculated according to Abdel-Gawad *et al* (1987).

To study photosynthate partitioning in the previous white maize hybrids; crop growth rate (CGR mg/cm^2/day) was determined by multiplying NAR x LAI according to Abdel-Gawad *et al* (1987). In addition, the percentages of carbohydrate and protein were estimated in vegetative organs; kernels and straw, whereas, oil percentages was estimated in kernels only. Although plant composition changes with age, these values may be fairly enough to provide an estimates of the partitioning coefficient. To calculate the photosynthate required to produce the different constituents, carbon equivalent was determined as shown by Hanson *et al* (1960). The production value for the pervious plant components was determined according to Penning De Vries *et al* (1974). The conversion factor to estimate carbon equivalent, production value, glucose required for synthesis, stored gram atoms, work carbon required in synthesis for carbohydrate; protein and oil in the differed plant components was used as reported by Hanson *et al* (1960), as well as, energy coefficient of crop index and energy coefficient of harvest index were calculated according to Abdel-Gawad *et al* (1987).

The total carbohydrate (%) in the different plant organs was determined according to the methods described by Dubios *et al* (1956). Total nitrogen (%) was determined according to A.O.C.S (1980) and was multiplied by 6.25 to calculated protein (%). Curde oil (%) was determined using the method described by A.O.C.S. (1980). In addition, energy per plant and per feddan at harvest was calculated using caloric conversion factors according to Hanson *et al* (1960).

Combined analysis was mode for the two growing seasons as results followed similar results according to Snedecor and Cochran (1982). For comparison between means, L.S.D. test at 5% level was used. Simple correlation coefficient for all possible combination between plant kernels yield and means of some of the characters studied after anthesis (i.e. 90 days after planting) were practiced according to Neter and Wasserman (1974).

Simple correlation of course do not permit the estimation of the direct effect of particular yield factor such as plant height, number of ears/plant, blades area/plant and LAI or any other factor of yield, since this variable is in some way associated with one of more variable which in turn associated with yield. Therefore, the path coefficient analysis which measures the direct influence of one variable upon another and permits the separation of the simple correlation coefficient into components of direct and indirect effects was done according to Wright (1934) and Snedecor and Cochran (1982).

Results and Discussion

Growth analysis:

The results illustrated in Table (1) observed significant differences between eleven white maize hybrids under study, i.e. the six single crosses S.C. 10, S.C. 122, S.C. 123, S.C. 124, S.C. Pioneer - 30k8 and S.C. Wataneia -4 and the five three way crosses T.W. Wataneia -1, T.W. Pioneer - 3057, T.W. 321, T.W. 323 and T.W. 324 in growth characters at 65, 80 and 95 days after sowing. Furthermore, plant height, number of active leaves/plant, stem + sheets dry weight/plant, number of ears/plant, blades dry weight/plant, flag leaf blade area, 4^{th} leaf blade area, blades area/plant and LAI for all hybrids tended to increase with advance of plant age up to 80 days after sowing and thereafter decreased, whereas; ears dry weight/plant, flag leaf angle, and 4^{th} leaf angle tended to increased with advance of plant age up to 95 days after sowing. In addition, S.C. 10 produced the greatest significant plant height, number of active leaves/plant, stem + sheets dry weight/plant, number of ears/plant, blades dry weight/plant, ears dry weight/plant, flag leaf blade area, 4^{th} leaf blade area, blades area/plant and LAI whereas the same hybrid characterized the lowest significant values from flag leaf angle and 4^{th} leaf angle compared with other ten hybrids under study and these results was true at 65, 80 and 95 days after sowing.

The hybrid differences in growth parameters under this study may be due to the differences in genetic structure, and the hybrid differences in glucose required for synthesis of different chemical constituents at different plant organs, in carbon equivalent and in partitioning of photosynthates among the plants (Ahmed and Hassanen, 2000), also, to the great differences between genotypes for mineral element concentrations (Clarch *et al*, 1997, and Abo El-Seoud and Wafaa, 2010). On the other hand, the inconstant decline in stem + sheets dry weight and blades dry weight/plant, again the inconstant increment in ears dry weight/plant caused after 80 days age may be due to the hybrid differences in migration coefficient of dry matter from vegetative organs (i.e. stem + sheets and blades to ears and the hybrid differences in photosynthate partitioning (Zaky *et al,* 1999, Ahmed and Hassanein, 2000, and Sadek *et al*, 2006).

It is note worthy that the hybrid differences in growth attributes herine in the study are in harmony with those obtained by Zaky *et al* (1999), Ahmed and Hassanein (2000), Keleinhez (2003), El-Koomy (2005), Sadek *et al* (2006 a and b) and Mirdad (2010).

Hybrid differences in yield and its components:

Data reported in Table (2) indicate that there were significant differences between the eleven white maize hybrids under study S.C. 10, S.C. 122, S.C. 123, S.C. 124, S.C. Pioneer 30k8, S.C. Wataneia -4, T.W. Wataneia -1, T.W. Pioneer 3057, T.W. 321, T.W. 323 and T.W. 324 in yield and its components except crop index where, S.C. 10 significantly outweighted the other ten white maize hybrids in plant height, stem and ear diameter, ear length, number of ears/plant, number of rows/ear, number of kernels/row, ears dry weight/plant, RPP_{kr}, RPP_{bio}, $RPP_{veg.}$, kernels and straw yields per plant and/or per fed., above ground biomass/fed., and harvest index, meanwhile the superiority in crop index failed to reach the significant level at 0.05. The hybrid differences Herne may be due to the differences in genetic structure between the eleven white maize hybrids and to the differences in growth characters (Table 1) and the differences in photosynthetic partitioning that observed in the following part of this study (Tables 3 and 4) that previously indicated by Zaky *et al* (1999), Ahmed and Hassanein (2000), and Sadek *et al* (2006). Also, the widely differences between maize genotypes for mineral concentrations that found by Clarch *et al* (1997) and Abo El-Seoud and Wafaa (2010) can be attribute the differences in yield and its components. Moreover, the significant superiority of S.C. 10 over the other ten white maize hybrids under this study in ears dry weight/plant, RPP_{kr}, RPP_{bio} and kernels yield per plant and/or per fed. may be due to the high yielding cultivar had a more vigorous system for generating reducing potentials during plant growth than did the less productive cultivar and the higher yielding cultivar has a higher photosynthetic electron transport chain potential, which is a genetically character more than lower yielding cultivar (Ahmed and Hassanein, 2000). Another factor may be a reason of the highest kernels yield per plant and/or per fed., are the maximum number of rows/ear and number of kernels/row that produced by S.C. 10 (Table 2). The greatest important of kernels number/rows in suggested the increase in number of kernels per unit area of land that have accompanied that recent increase in yield shown by new cultivars (Pendelton *et al*, 1968). On the other hand, the small angle between stem and flag leaf blade and 4^{th} leaf blade of S.C. 10 may be due to a reason of kernels yield, where, the effect of erect angle might be attributed to leaf orientation and its effect on light interception and penetration in the plant canopy (Ahmed and Hassanein, 2000). Moreover, Puccidge (1971) reported that changes in LAI caused a variation in CO_2 uptake and the differences in kernels yield from anthesis onwards were correlated with LAI and CO_2 uptake, thus, the hybrid differences in LAI in Table (1) may be a cause hybrid differences in kernels yield.

Hybrid differences in yield and its components in this study are in harmony with those obtained by Zaky *et al* (1999), Ahmed and Hassanein (2000), Kleinhez (2003), El-Koomy (2005), Sadek *et al* (2006 a and b) and Mirdad (2010).

Hybrid differences in photosynthate partitioning:

The partitioning coefficient would be determined by the capacity of the photosynthetic sink related by the ear. When plants reached the final weeks of the filling period (soft dough stage to ripe stage), the coefficient of partitioning may increase evidence for these is shown by very rapid decline in the canopy in the final weeks and the possible scavening of nutrients from the vegetative plant parts.

There were significant differences between maize hybrids in crop growth rate (Table 3) and ears dry weight/plant at different stages of growth (Table 1). Furthermore, S.C. 10 white hybrid significantly exceeded the other ten white hybrids in crop growth rate (Table 3) and ears dry weight/plant (Table 1). Also, crop growth rate tended to increase with advancing age until 80 days and then declined with advancing age from 80 to 95 days after sowing (Table 3). On the contrary ears dry weight/plant tended to increase lineary from 65 days after planting (Table 1).

It is worthy that CGR values of vegetative organs reflect the total amount of photosynthate partitioning into the yield components. The partitioning coefficient can not be approximated from a simple ratio of the slope of crop growth rate since more photosynthate is required to produce a given amount of kernels than the same amount of vegetative material. The additional photosynthate is required to produce the additional protein and oil in kernels (Hanson *et al*, 1960, Penning De Vries *et al*, 1974, Mc Grow, 1977 and Ahmed and Hassanein, 2000).

To estimate the amount of photosynthate needed to produce a quantity of ears in the same quantity of vegetative material, the relative quantities of carbohydrate, protein and oil should be detected. Significant differences were found among the eleven white maize hybrids in carbohydrate percentage of vegetative organs, kernels and straw, in oil percentage in kernels, as well as, in protein percentage in straw (Table 3). Furthermore, S.C. 10 significantly exceeded the other ten white hybrids (S.C. 122, S.C. 123, S.C. 124, S.C. Pioneer 30K8, S.C. Wataneia -4, T.W. Wataneia -1, T.W. Pioneer 3057, T.W. 321, T.W. 323 and T.W. 324) in carbohydrate percentage of vegetative organs, kernels and straw, in oil percentage of kernels and protein % of straw. On the other hand, the superiority of S.C. 10 in protein % per vegetative organs and kernels are the other ten hybrids failed to reach the significant level at 0.05 (Table 3).

Data illustrated in Table (3) show clearly that glucose required for synthesis of the chemical compounds by the various maize white hybrids components. Differences between maize hybrids in glucose required for synthesis of protein in vegetative organs, of carbohydrate and protein in kernels and straw, as well as, oil in kernels were significant, whereas the variation between hybrids in glucose required for synthesis of vegetative organs was insignificant. In addition, S.C. 10 have the highest significant values from glucose required for synthesis of protein in vegetative organs, kernels (except on S.C. 123 and S.C. 124) and straw of carbohydrate in kernels and straw of oil in kernels compared with other hybrids under study, while the inferiority of S.C. 122, S.C. 123, S.C. 124, S.C. Pioneer 30K8, S.C. Wataneia -4, T.W. Wataneia -1, T.W. Pioneer 3057, T.W. 321, T.W. 323 and T.W. 324 than S.C 10 was insignificant.

With respect of carbon equivalent, according to Hanson *et al* (1960) carbon equivalent is defined as the gram atoms of sugar carbon required to produce product inclucling both gram atoms of work carbon lost in the synthesis and gram atom of carbon stored in the product. Data reported in Table (3) revealed that significant differences between white maize hybrids in carbon equivalent for each carbohydrate and protein of vegetative organs, kernels and straw, as well as, for oil of kernels. Generally, S.C. 10 harvested a high carbon equivalent for each carbohydrate and protein in vegetative organs, kernels and straw and for oil in kernels except differences between S.C. 10 and S.C. 123, S.C. 124 and T.W. 324 in carbon equivalent for carbohydrate in straw were insignificant.

Table (4) show that there were significant differences among the tested eleven white maize cultivar in yield energy per plant and per fed., where maize cultivars was significantly differed in energy yield for carbohydrate, protein and oil. Moreover, S.C 10 significantly surpassed the other ten hybrids under study in energy yield of carbohydrate, protein and oil in kernels per plant and/or fed and of carbohydrate and protein in straw per plant and/or fed., also.

It is worthy to mention that data reported in Table (4) Shaw that S.C. 10 also significantly characterized by its high values from energy coefficient of crop index and harvest index.

Thus it is could be concluded that the present results are in harmony with the results obtained by Hanson *et al*. (1960), Penning De Vries *et al*. (1974), Mc Graw (1977) and Ahmed and Hassanein (2000).

Again, as mentioned before, harvested while maize yield can be increased by growing S.C. 10, S.C. 124, S.C. 123, S.C. 122, T.W. 324 and T.W. 321 that characterized by highest efficiency in partitioning of photosynthetic towards economic yield.

Correlation studies:

Table (5) indicate clearly that highly significant and positive correlation were recorded between plant kernels yield and each one of ear diameter, ear length, ear dry weight/plant, number of rows/ear, number of kernels/row, RPP_{kr}, flag leaf blade/area, 4th leaf blade area, blades area/plant and LAI, between plant height and number of rows/ear, number of kernels/row, RPP_{kr}, flag leaf blade area, 4th leaf blade area, blades area/plant and LAI, between ear diameter and each of ears dry weight/plant, number of rows/ear, number of kernels/row, RPP_{kr}, flag leaf blade area, 4th leaf blade area, blades area/plant and LAI, also, the relationships between ear length and number of kernels/row, RPP_{Kr}, blades area/plant and LAI and between number of ears/plant and ears dry weight/plant, number of rows/ear, number of kernels/row, flag leaf blade area, 4th leaf blade area, blades area/plant and LAI were highly significant and positive. Moreover, the simple correlation coefficient between ears dry weight/plant and number of rows/ear, number of kernels/row, flag leaf blade area, 4th leaf blade area, blades area and LAI, between number of rows/ear and number of kernels/row, RPP_{kr}, flag leaf blade area, 4th leaf blade area, blades area/plant and LAI, between number of kernels/row and RPP_{kr}, flag leaf blade area, 4th leaf blade area, blades area/plant and LAI and between RPP_{kr} and 4th leaf blade area, blades area/plant and LAI was positive and highly significant. Furthermore, the relation between blades area/plant and flag leaf blade area, 4th leaf blade area and LAI and between LAI and each of flag leaf area and 4th leaf blade area was positive and high significant (Table 5).

On the other hand, the correlation coefficient between ear length and ear diameter, number rows/ear, flag leaf blade area and 4th leaf blade area, between flag leaf area and RPP_{kr}, 4th leaf blade area, flag leaf angle, and between ears dry weight/plant and RPP_{kr} was positive and significant. On the contrary, the relationship between 4th leaf angle and plant height, ear diameter and flag leaf angle and between plant height and flag leaf angle was negative and significant. In addition, the rest of correlation coefficient was positive and insignificant except between plant height and ear length, flag leaf angle and 4th leaf angle, between flag leaf angle and plant height, ear length, number of ears/plant, number of rows/ear, number of kernels/row, and RPP_{kr} and between 4th leaf angle and plant height, ear length, number of ears/plant, number of kernels/row and RPP_{kr} was negative and insignificant.

Path coefficient analysis:

Table (6) shows that partitioning of overage for simple correlation coefficient between kernels yield/plant and some yield components, i.e. ear diameter, ear length, number of ears/plant, ears dry wt. /plant, number of rows/ear, RPP_{kr} and number of kernels/row as well as some growth characters, i.e. flag leaf area, 4th leaf area, blades area/plant and LAI as the average of eleven white maize hybrids under study. Flag leaf area proved to have a high direct effect on kernels yield/plant compared with number of kernels/row, LAI, ears dry weight/plant, blades area/plant, and RPP_{kr}, whereas, ear diameter have a high negative direct effect on kernels yield/plant compared with number of ears/plant, ear length and 4th leaf area, since the average means of the direct effect were 1.985, 1.098, 1.043, 0.886, 0.659, 0.461, 0.229, -2.472, -1.51, -0.886 and -0.078, respectively. Again, as mentioned before (Table 5) total correlation coefficient was most pronounced in ear diameter (0.893) than in flag leaf area (0.864), number of ears/plant (r=0.836), ear length (r=0.806), number of kernels/row (r=0.802), ears dry weight/plant (r=0.762), LAI (r=0.717), 4th leaf area (r=0.658), number of rows/ear (r=0.621), blades area/plant (r=0.574) and RPP_{kr} (r=0.567).

Table (7) shows that the direct effect of ear diameter was 7.80% of the variation being higher than that of flag leaf area (5.03%), number of ears/plant (2.91%), number of kernels/rows (1.54%), LAI (1.39%), ear length (1.00%), ears dry wt./plant (0.55%), blades area/plant (0.27%), RPP_{kr} (0.07%), 4th leaf area (0.01%) and

No. of rows/ear (0.0004%) of the variation, respectively. The joint effect of ear diameter with ear length, No. of ears/plant, ear dry wt./plant, No. of rows/ear, No. of kernels/row, RPP_{kr}, flag leaf area, 4^{th} leaf area, blades area/plant and LAI formed 2.43, 2.59, 3.08, 0.09, 4.98, 1.06, 8.37, 0.27, 2.38 and 4.97% of the variation, respectively. Moreover, the joint effect of ear length with No. of ears/plant, ears dry wt./plant, No. of rows/ear, No. of kernels/row, RPP_{kr}, flag leaf area, 4^{th} leaf area, blades area/plant and LAI were 2.88, 0.49, 0.02, 1.90, 0.36, 2.16, 0.09, 0.76 and 1.68 % of the variation, respectively.

Table 1: Hybrid differences in growth characters of eleven white maize hybrids (Combined analysis of 2008 and 2009 seasons)

Hybrids Plant age	S.C. 10	S.C. 112	S.C. 123	S.C. 124	S.C. Pioneer 30k8	S.C. Wataneia -4	S.C. Wataneia -1	T.W. Pioneer 3057	T.W. 321	T.W. 323	T.W. 324	L.S.D. at 0.05 level
						Plant height "cm"						
65	227.09	211.67	214.85	222.8	217.8	196.5	190.85	210.2	201	206.3	220.1	2.71
80	304.8	285.1	260.3	301.22	267	269	263	282	275	278	271.79	1.82
95	287.5	250	239.75	280	260.18	226.5	225	233.4	230	234	265.2	4.01
						Number of active leaves/plant						
65	17	15.1	15.84	16.5	16	14	14	15	14.5	16.25	16.5	0.28
80	18.5	16	16	18	17.2	16	16	16	16	17	17	0.25
95	18	15.33	15.5	17	17	15	15	14. 5	14.5	16	16.67	0.54
						Stem + sheats dry wt. "g/plant"						
65	85.71	76.5	77.52	82.11	78.43	68.07	65.9	73.08	70.2	72.36	81.66	2.14
80	96.13	85.09	87.38	92.67	88.11	75.8	74.46	80.86	76.29	78.64	90.78	2.6
95	87.83	77.66	78.54	85.78	81.89	70.67	69.14	75.08	72.96	73.31	83.15	1.82
						No. of ears/plant						
65	-	-	-	-	-	-	-	-	-	-	-	-
80	1.5	1. 20	1.2	1.33	1.33	1.17	1.1	1.17	1.3	1.3	1.33	0.09
95	1.45	1.1	1.1	1.25	1.3	1.1	1	1.1	1.25	1.25	1.3	0.04
						Blades dry weight "g/plant"						
65	49.85	42.15	43.61	47.81	44.55	38.1	37.22	40.57	38.2	39.85	45.91	1.14
80	56.17	48.31	49.76	54.2	51.36	45.89	45.64	48.05	46.7	47.6	52.14	1.91
95	52.74	46.45	46.88	50.08	47.54	41.15	40.5	44.21	42.5	43.15	49.71	1.69
						Ears dry weight "g/plant"						
65	-	-	-	-	-	-	-	-	-	-	-	-
80	61.86	54.11	55.14	60.42	56.34	45.26	46.52	53.07	49.18	51.77	58.71	1.36
95	92.65	83.1	84.55	90.58	85.76	79.11	77.69	82.49	78.9	80.15	87.42	1.65
						Flag leaf blade area "cm2"						
65	145.39	133.5	135.86	143.45	139.42	121.27	119.4	131.73	126.7	128.11	140.51	1.35
80	164.74	142.53	146.75	157.21	148.95	127.44	126.21	139.8	134.52	137.6	154.84	3.59
95	150.45	131.6	137.08	146.67	139.81	119.25	117.59	129.4	120.1	126.91	142.74	2.81
						4th leaf blade area "cm2"						
65	492.13	466.78	471.99	487.1	473.3	431.79	427.26	460.86	438.52	453.49	481.5	3.91
80	519.21	493.5	495	510.74	498.5	471.5	469	492.93	475.8	488.64	500.31	4.68
95	475.9	453.97	454.65	465	456	439.2	438.7	452.89	446.88	450.75	458.76	5.05
						Blades area "cm2/plant"						
65	5451.6	5109.6	5171	5404	5258.73	4780	4703	5041.93	4813	4864.9	5352.91	12.13
80	5473	5261.13	5295.5	5450	5361.99	4860.5	4800	5188.66	4936.4	5085.75	5395.27	14.01
95	5420	5173.97	5188.6	5372	5200	4794	4773	5091.74	4852.6	5001.16	5300.09	16.84
						Flag leaf angle						
65	36.77	42.99	42.35	39.13	41.99	47.5	49.3	43.57	45.3	44.26	41.56	1.3
80	39.41	48.33	47.72	43.4	46.56	52.6	55.16	49.2	48.97	46.13	45.61	2.74
95	47.9	54.35	52.03	48.35	51.47	56.3	61.5	53.1	54.78	52.9	50.43	2.45
						4th leaf angle						
65	41.97	50.3	49.7	43.26	47.94	55.1	55.09	52.3	54.41	53.7	45.8	1.19
80	47.64	58.05	57.91	50.11	53.65	63.4	64.13	60.71	62.62	61.4	51.3	1.28
95	56.1	64.7	63.32	57.9	61.43	70.31	70.99	67.5	68.8	68.48	59.24	0.58
						Leaf area index						
65	3.63	3.41	3.45	3.6	3.51	3.19	3.14	3.36	3.21	3.24	3.57	0.02
80	3.65	3.51	3.53	3.63	3.57	3.24	3.2	3.46	3.29	3.39	3.6	0.01
95	3.61	3.45	3.46	3.58	3.47	3.2	3.18	3.39	3.24	3.33	3.53	0.02

Table 2: Cultivar differences in yield and its components of cultivars white hybrids (Combined analysis of 2008 and 2009 seasons)

Hybrids Plant age	S.C. 10	S.C. 122	S.C. 123	S.C. 124	S.C. Pioneer 30k8	S.C. Wataneia -4	S.C. Wataneia -1	T.W. Pioneer 3057	T.W. 321	T.W. 323	T.W. 324	L.S.D. at 0.05 level
Plant height "cm"	283.67	250	253.75	275.5	257.4	224.8	223	230.28	229	232.5	262.45	2.17
Stem diameter "cm"	3.09	2.5	2.75	3	2.87	2.4	2.38	2.48	2.4	2.45	2.95	0.04
Ear diameter "cm"	5.88	4.9	5	5.59	5.04	4.4	4.4	4.7	4.5	4.6	5.5	0.12
Ear length "cm"	30.15	26.2	27.5	29.5	27.8	23	22.1	25	24	24.75	28.7	0.36

Table 2: Continue

No. of ears/plant	1.45	1.1	1.1	1.25	1.3	1.1	1	1.1	1.25	1.25	1.3	0.04
No. of rows/ear	14.25	13.5	13.5	14	14	12.35	12	12	13.5	13.65	14	0.14
No. of kernels/row	52.2	48	48.75	51.36	46.2	44.75	42	47	47.75	49	50.25	0.27
Ears dry weight "g/plant"	329.26	279.52	284.39	305.4	288.84	257.1	250	265.13	257	258.26	296.53	21.45
RPPkr "g/LAI"	68.44	57.6	60.93	66.31	55.74	54.42	48.25	47.92	67.12	56.19	65.3	1.33
RPPbio "g/LAI"	150.52	129.26	133.05	144.63	124	123.2	111.09	108.05	147.53	125.73	141.05	2.66
RPPveg."g/LAI"	82.08	71.66	72.12	78.32	68.26	68.78	62.84	60.13	80.41	69.54	75.75	1.71
Kernels yield ."g/plant"	248.45	200.44	213.25	239.38	196.2	175.22	153.91	164.38	219.47	188.79	233.13	4.02
Straw yield ."g/plant"	297.93	249.38	250.43	282.75	240.49	221.5	200.46	206.22	262.96	233.65	270.42	11.33
Migration coefficient	0.603	0.621	0.613	0.585	0.661	0.648	0.705	0.715	0.533	0.611	0.589	0.07
Kernels yield "ton/fed"	4.59	4.12	4.17	4.45	4.08	3.91	3.35	3.6	4.2	3.97	4.29	0.11
Straw yield "ton/fed"	4.8	4.37	4.38	4.71	4.33	4.17	3.93	4.08	4.5	4.25	4.62	0.05
Above ground biomass "ton/fed"	9.39	8.49	8.55	9.16	8.41	8.08	7.28	7.68	8.7	8.22	8.91	0.18
Crop index	0.489	0.485	0.488	0.485	0.485	0.484	0.46	0.469	0.483	0.483	0.481	n.s
Harvest index	0.957	0.943	0.952	0.945	0.942	0.938	0.852	0.882	0.933	0.934	0.929	0.005

Table 3: Hybrid differences in carbohydrate, protein and oil percentage, glucose required for synthesis, carbon equivalent and crop growth rate of white maize hybrids. (Combined analysis of 2008 and 2009 seasons)

Hybrids Chemical Constituents	S.C. 10	S.C. 122	S.C. 123	S.C. 124	S.C. Pioneer 30k8	S.C. Wataneia 4	T.W. Wataneia 1	T.W. Pioneer 3057	T.W. 321	T.W. 323	T.W. 324	L.S.D. at 0.05 level
					Carbohydrate, protein and oil percentages							
Vegetative organs:-												
Carbohydrate	69.88	69.29	69.2	69.05	69.4	66.6	66.5	67.56	67.72	67.9	68.73	0.23
Protein	11.88	10.67	11.38	11.87	11.15	10.12	10.07	10.21	9.72	9.76	11.34	n.s
Kernels :-												
Carbohydrate	77.81	73.3	74.2	76.9	72.84	71.69	71.58	70.7	72.41	73.05	72.78	0.52
Protein	11.98	11.38	11.6	11.7	11.37	10.72	10.85	11.3	11.4	11.15	10.76	n.s
Oil	4.87	4.35	4.32	4.76	4.55	4.2	4.03	4.49	4.62	4.65	4.73	0.08
Straw :-												
Carbohydrate	74.23	72.77	73.83	74	72.99	71	69.39	72.86	73	73.15	73.67	0.17
Protein	10.94	10.28	10.67	10.52	9.92	9.33	9.4	9.85	9.48	9.69	9.72	0.15
					Glucose required for synthesis							
Vegetative organs:-												
Carbohydrate	0.819	0.812	0.811	0.809	0.814	0.781	0.78	0.797	0.794	0.796	0.806	n.s
Protein	0.192	0.172	0.184	0.191	0.18	0.163	0.162	0.165	0.157	0.157	0.183	0.001
Kernels :-												
Carbohydrate	0.912	0.859	0.87	0.902	0.854	0.84	0.839	0.829	0.849	0.856	0.853	0.005
Protein	0.193	0.184	0.187	0.189	0.183	0.173	0.175	0.182	0.184	0.18	0.174	0.007
Oil	0.139	0.124	0.123	0.136	0.128	0.12	0.115	0.128	0.132	0.132	0.135	0.002
Straw :-												
Carbohydrate	0.941	0.853	0.856	0.904	0.856	0.832	0.813	0.854	0.856	0.858	0.864	0.012
Protein	0.176	0.166	0.172	0.17	0.16	0.15	0.152	0.159	0.153	0.156	0.157	0.003
					Carbon equivalent							
Vegetative organs:-												
Carbohydrate	27.95	27.72	27.68	27.62	27.76	26.64	26.6	27.02	27.09	27.16	27.49	0.14
Protein	9.34	8.39	8.94	9.33	9.06	7.96	7.92	8.03	7.64	7.67	8.92	0.001
Kernels :-												
Carbohydrate	31.12	29.32	29.68	30.7	29.14	28.68	28.63	28.28	28.96	29.22	29.11	0.16
Protein	0.42	8.95	9.12	9.2	8.94	8.43	8.53	8.88	8.96	8.77	8.46	0.15
Oil	5.56	4.97	4.93	5.44	5.2	4.8	4.6	5.13	5.28	5.3 1	5.40	0.11
Straw :-												
Carbohydrate	29.69	29.11	29.53	29.6	29.2	28.4	27.76	29.14	29.2	29.26	29.47	0.26
Protein	8.6	8.08	8.39	8.27	7.8	7.33	7.39	7.74	7.45	7.62	7.64	0.09
	Crop growth rate (mg/cm2/day)											
a. 65 – 85 days after sowing	6.43	4.5	4.87	5.49	4.13	3.27	2.96	3.86	4.51	4.03	4.94	0.029
b. 80 – 95 days after sowing	4.52	3.28	3.56	4.01	3.11	2.1	1.87	2.55	3.36	2.97	3.7	0.01

Table 4: Hybrid differences in energy yield per plant and / or per fed. at harvest of eleven white maize hybrids (Combined analysis of 2008 and 2009 seasons).

	S.C. 10	S.C. 122	S.C. 123	S.C. 124	S.C. Pioneer 30k8	S.C. Wataneia 4	T.W. Wataneia 1	T.W. Pioneer 3057	T.W. 321	T.W. 323	T.W. 324	L.S.D. at 0.05 level
					Yield energy/plant at harvest "k cals"							
Kernels :-												
Carbohydrate	763.6	580.34	625.01	727.13	564.5	496.18	435.17	459.06	627.73	544.75	670.2	2.67
Protein	136.02	104.24	113.05	127.99	101.95	85.84	76.32	84.89	114.34	96.2	114.64	4.94
Oil	113.74	81.96	86.6	107.11	83.91	69.18	58.3	73.81	95.31	82.52	103.65	2.44
Total	1013.36	766.54	824.66	962.23	750.36	651.2	569.79	617.76	837.38	723.47	888.49	19.65

Table 4: Continue

Straw :-												
Carbohydrate	873.56	647.86	725.87	826.48	693.36	621.2	549.44	593.49	758.25	675.11	786.91	8.78
Protein	148.95	117.16	122.11	135.94	109.02	94.44	86.11	92.83	113.92	103.47	120.12	5.21
Total	1450.14	876.18	847.98	962.42	802.38	715.64	635.55	686.32	872.17	778.58	907.03	14.72
Yield energy/fed. at harvest 106k cals												
Kernels :-												
Carbohydrate	14.11	11.93	12.22	13.51	11.68	11.07	9.47	10.05	12.01	11.46	12.33	0.51
Protein	2.51	2.14	2.21	2.38	2.12	1.92	1.66	1.86	2.19	2.02	2.11	0.12
Oil	2.1	1.68	1.69	1.99	1.73	1.54	1.27	1.52	1.82	1.74	1.91	0.04
Total	18.72	15.75	16.12	17.88	15.53	14.53	12.4	13.43	16.02	15.22	16.35	0.39
Straw :-												
Carbohydrate	14.07	12.56	12.7	13.76	12.48	11.69	10.77	11.74	12.98	12.28	13.44	0.34
Protein	2.4	2.05	2.14	2.26	1.96	1.78	1.69	1.84	1.95	1.88	2.05	0.11
Total	16.47	14.61	14.84	16.02	14.44	13.47	12.46	13.58	14.93	14.16	15.49	
Energy coefficient												
Energy coefficient for crop index	0.53	0.52	0.52	0.53	0.52	0.52	0.5	0.5	0.52	0.52	0.51	0.01
Energy coefficient for harvest index	1.14	1.08	1.09	1.12	1.08	1.08	1	0.99	1.07	1.07	1.06	0.02

Table 5: simple correlation coefficient between kernels yield and some yield components and growth characters of eleven white maize hybrids (Combined analysis of 2008 and 2009 seasons).

		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
Kernels yield "g/plant"	X_1	0.242	0.893**	0.806**	0.836**	0.762**	0.621**	0.802**	0.567**	0.864**	0.658**	-0.439*	-0.505*	0.571**	0.717**
Plant height "cm"	X_2		-0.274	-0.227	0.351	0.419	0.581**	0.645**	0.699**	0.548**	0.539**	-0.393	-0.384	0.625**	0.648**
Ear diameter "cm"	X_3			0.434*	0.272	0.741**	0.768**	0.719**	0.733**	0.668**	0.544**	-0.422	-0.43*	0.822**	0.756**
Ear length "cm"	X_4				0.303	0.328	0.447*	0.753**	0.688**	0.483*	0.495*	-0.129	-0.204	0.692**	0.711**
No. of ears / plant	X_5					0.701**	0.714*	0.777**	0.388	0.799**	0.759**	-0.141	-0.178	0.697**	0.749**
Ears dry wt. "gm/plant"	X_6						0.56**	0.581**	0.472*	0.708**	0.687**	-0.845**	-0.758**	0.744**	0.801**
No. of rows / ear	X_7							0.764**	0.745**	0.839**	0.684**	-0.305	-0.348	0.625**	0.667**
No. of kernels / row	X_8								0.63**	0.788**	0.792**	-0.259	-0.280	0.853**	0.797**
RPP_{kr}	X_9									0.513*	0.561**	-0.104	-0.172	0.642**	0.771**
Flag leaf area "cm^2"	X_{10}										0.518*	0.491*	0.324	0.628**	0.663**
4^{th} leaf area "cm^2"	X_{11}											0.201	0.262	0.743**	0.798**
Flag leaf angle	X_{12}												-0.518*	0.184	0.172
4^{th} leaf angle	X_{13}													0.134	0.198
Blades area cm^2/ plant	X_{14}														0.993**
Leaf area index	X_{15}														

Table 6: Partitioning of simple correlation coefficient between kernels yield/plant and some yield components and growth parameters in eleven white maize hybrid.

Source	Correlation	Source	Correlation	Source	Correlation
Kernels yield via. ear diameter		Kernels yield via. No. of ears/plant		Kernels yield via. No. of rows/ear	
Direct effect	-2.472	Direct effect	-1.51	Direct effect	0.018
Indirect via. ear length	-0.385	Indirect via. ear diameter	-0.672	Indirect via. ear diameter	-1.898
Indirect via. No. of ears/plant	-0.414	Indirect via. ear length	-0.458	Indirect via. ear length	-0.396
Indirect via. ears dry wt. /plant	0.742	Indirect via. ears dry wt. /plant	0.462	Indirect via. No. of ears/plant	-1.078
Indirect via. No. of rows/ear	0.013	Indirect via. No. of rows/ear	0.013	Indirect via. ears dry wt. /plant	0.369
Indirect via. No. of kernels/row	0.789	Indirect via. No. of kernels/row	0.583	Indirect via. No. of kernels/row	0.839
Indirect via. RPPkr	0.168	Indirect via. RPPkr	0.089	Indirect via. RPPkr	0.171
Indirect via. flag leaf area	1.326	Indirect via. flag leaf area	1.286	Indirect via. flag leaf area	1.655
Indirect via. 4th leaf area	-0.042	Indirect via. 4th leaf area	-0.059	Indirect via. 4th leaf area	-0.053
Indirect via. blades area/plant	0.379	Indirect via. blades area/plant	0.321	Indirect via. blades area/plant	0.288
Indirect via. LAI	0.789	Indirect via. LAI	0.781	Indirect via. LAI	0.696
Total correlation	0.893	Total correlation	0.836	Total correlation	0.621
Kernels yield via. ear length		Kernels yield via. ears dry wt. /plant		Kernels yield via. No. of kernels/row	
Direct effect	-0.886	Direct effect	0.659	Direct effect	1.098
Indirect via. ear diameter	1.073	Indirect via. ear diameter	-1.832	Indirect via. ear diameter	-1.777
Indirect via. No. of ears/plant	-0.458	Indirect via. ear length	-0.291	Indirect via. ear length	-0.667
Indirect via. ears dry wt. /plant	0.216	Indirect via. No. of ears/plant	-1.059	Indirect via. No. of ears/plant	-1.173
Indirect via. No. of rows/ear	0.046	Indirect via. No. of rows/ear	0.01	Indirect via. ears dry wt. /plant	0.383
Indirect via. No. of kernels/row	0.827	Indirect via. No. of kernels/row	0.838	Indirect via. No. of rows/ear	0.014
Indirect via. RPPkr	0.153	Indirect via. RPPkr	0.108	Indirect via. RPPkr	0.198
Indirect via. flag leaf area	0.959	Indirect via. flag leaf area	1.405	Indirect via. flag leaf area	1.564
Indirect via. 4th leaf area	-0.039	Indirect via. 4th leaf area	-0.054	Indirect via. 4th leaf area	-0.062
Indirect via. blades area/plant	0.319	Indirect via. blades area/plant	0.343	Indirect via. blades area/plant	0.393
Indirect via. LAI	0.742	Indirect via. LAI	0.835	Indirect via. LAI	0.831
Total correlation	0.806	Total correlation	0.762	Total correlation	0.802
Kernels yield via. RPPkr		Kernels yield via. 4th leaf area		Kernels yield via. LAI	
Direct effect	0.229	Direct effect	-0.078	Direct effect	1.043
Indirect via. ear diameter	-1.812	Indirect via. ear diameter	-1.345	Indirect via. ear diameter	-1.869
Indirect via. ear length	-0.61	Indirect via. ear length	-0.439	Indirect via. ear length	-0.63
Indirect via. No. of ears/plant	-0.586	Indirect via. No. of ears/plant	-1.146	Indirect via. No. of ears/plant	-1.131
Indirect via. ears dry wt. /plant	0.311	Indirect via. ears dry wt. /plant	0.453	Indirect via. ears dry wt. /plant	0.528
Indirect via. No. of rows/ear	0.013	Indirect via. No. of rows/ear	0.012	Indirect via. No. of rows/ear	0.012
Indirect via. No. of kernels/row	0.948	Indirect via. No. of kernels/row	0.87	Indirect via. No. of kernels/row	0.875
Indirect via. flag leaf area	1.018	Indirect via. RPPkr	0.128	Indirect via. RPPkr	0.177
Indirect via. 4th leaf area	-0.044	Indirect via. flag leaf area	1.028	Indirect via. flag leaf area	1.316
Indirect via. blades area/plant	0.296	Indirect via. blades area/plant	0.343	Indirect via. 4th leaf area	-0.662
Indirect via. LAI	0.804	Indirect via. LAI	0.832	Indirect via. blades area/plant	0.458
Total correlation	0.567	Total correlation	0.658	Total correlation	0.717
Kernels yield via. flag leaf area		Kernels yield via. blades area/plant			
Direct effect	1.985	Direct effect	0.461		
Indirect via. ear diameter	-1.649	Indirect via. ear diameter	-2.032		
Indirect via. ear length	-0.462	Indirect via. ear length	-0.613		
Indirect via. No. of ears/plant	-1.26	Indirect via. No. of ears/plant	-1.052		
Indirect via. ears dry wt. /plant	0.467	Indirect via. ears dry wt. /plant	0.49		

Table 6: Continue

Indirect via. No. of rows/ear	0.015	Indirect via. No. of rows/ear	0.011
Indirect via. No. of kernels/row	0.836	Indirect via. No. of kernels/row	0.937
Indirect via. RPPkr	0.117	Indirect via. RPPkr	0.147
Indirect via. 4th leaf area	-0.04	Indirect via. flag leaf area	1.247
Indirect via. blades area/plant	0.29	Indirect via. 4th leaf area	-0.058
Indirect via. LAI	0.682	Indirect via. LAI	1.036
Total correlation	0.864	Total correlation	0.574

Table 7: Direct and joint effects of some yield components and growth parameters as percentages of yield variation in eleven white maize hybrids

Characters	Coefficient of determination	Percentage contributed%	Characters	Coefficient of determination	Percentage contributed%	Characters	Coefficient of determination	Percentage contributed%
Ear diameter	6.111	7.80	Ear length X Ears dry wt./plant	-0.383	0.49	Ears dry wt./plant X LAI	1.109	1.42
Ear length	0.785	1.00	Ear length X No. of rows/ear	-0.014	0.02	No. of rows/ear X No. of kernels/row	0.028	0.04
No. of ears/plant	2.280	2.91	Ear length X No. of kernels/row	-1.485	1.90	No. of rows/ear X RPP_{kr}	0.006	0.01
Ears dry wt./plant	0.434	0.55	Ear length X RPP_{kr}	-0.279	0.36	No. of rows/ear X Flag leaf area	0.06	0.08
No. of rows/ear	0.0003	0.0004	Ear length X Flag leaf area	-1.699	2.16	No. of rows/ear X 4^{th} leaf area	-0.002	0.002
No. of kernels/row	1.206	1.54	Ear length X 4^{th} leaf area	0.068	0.09	No. of rows/ear X Blades area/plant	0.023	0.03
RPP_{kr}	0.052	0.07	Ear length X Blades area/plant	-0.595	0.76	No. of rows/ear X LAI	0.025	0.03
Flag leaf area	3.940	5.03	Ear length X LAI	-1.314	1.68	No. of kernels/row X RPP_{kr}	0.433	0.55
4^{th} leaf area	0.006	0.01	No. of ears/plant X Ears dry wt./plant	-1.395	1.78	No. of kernels/row X Flag leaf area	3.435	4.39
Blades area/plant	0.213	0.27	No. of ears/plant X No. of rows/ear	-0.039	0.05	No. of kernels/row X 4^{th} leaf area	-0.316	0.40
LAI	1.088	1.39	No. of ears/plant X No. of kernels/row	-2.577	3.28	No. of kernels/row X Blades area/plant	0.864	1.10
Ear diameter X Ear length	1.901	2.43	No. of ears/plant X RPP_{kr}	-0.268	0.34	No. of kernels/row X LAI	1.825	2.33
Ear diameter X No. of ears/plant	2.031	2.59	No. of ears/plant X Flag leaf area	-4.79	6.11	RPP_{kr} X Flag leaf area	0.466	0.59
Ear diameter X Ears dry wt./plant	-2.414	3.08	No. of ears/plant X 4^{th} leaf area	0.179	0.23	RPP_{kr} X 4^{th} leaf area	-0.02	0.03
Ear diameter X No. of rows/ear	-0.068	0.09	No. of ears/plant X Blades area/plant	-0.97	1.24	RPP_{kr} X Blades area/plant	0.136	0.17
Ear diameter X No. of kernels/row	-3.903	4.98	No. of ears/plant X LAI	-2.397	3.06	RPP_{kr} X LAI	0.368	0.47
Ear diameter X RPP_{kr}	-0.829	1.06	Ears dry wt./plant X No. of rows/ear	0.013	0.02	Flag leaf area X 4^{th} leaf area	-0.190	0.24
Ear diameter X Flag leaf area	-6.556	8.37	Ears dry wt./plant X No. of kernels/row	0.840	1.07	Flag leaf area X Blades area/plant	1.149	1.47
Ear diameter X 4^{th} leaf area	0.209	0.27	Ears dry wt./plant X RPP_{kr}	0.142	0.18	Flag leaf area X LAI	2.745	3.50
Ear diameter X Blades area/plant	-1.873	2.38	Ears dry wt./plant X Flag leaf area	1.852	2.36	4^{th} leaf area X Blades area/plant	-0.32	0.41
Ear diameter X LAI	-3.898	4.97	Ears dry wt./plant X 4^{th} leaf area	-0.071	0.09	4^{th} leaf area X LAI	-0.01	0.01
Ear length X No. of ears/plant	2.262	2.89	Ears dry wt./plant X Blades area/plant	0.452	0.58	Blades area/plant X LAI	0.955	1.22
R2							0.995	100.00
Residual							0.004	0.00
Total							1.00	100.00

The joint effect of No. of ears/plant with ears dry wt./plant, No. of rows/ear, No. of kernels/row, RPP_{kr}, flag leaf area, 4^{th} leaf area, blades area/plant, and LAI were 1.78, 0.05, 3.28, 0.34, 6.11, 0.23, 1.24 and 3.06% of the variation, respectively, whereas, the joint effect of ears dry wt./plant with No. of rows/ear, No. of kernels/row, RPP_{kr}, flag leaf area, 4^{th} leaf area, blades area/plant, and LAI formed 0.02, 1.07, 0.18, 2.36, 0.09, 0.58 and 1.42% of the variation, respectively. In addition, the joint effect of No. of rows/ear with No. of kernels/row, RPP_{kr}, flag leaf area, 4^{th} leaf area, blades area/plant, and LAI were 0.04, 0.1, 0.08, 0.002, 0.03 and 0.03% of the variation, respectively, meanwhile, the joint effect of No. of kernels/rows with RPP_{kr}, flag leaf area, 4^{th} leaf area, blades area/plant, and LAI were amounted 0.55, 4.38, 0.40, 1.10 and 2.33% of the variation. On the other hand, the joint effect of RPP_{kr} with flag leaf area, 4^{th} leaf area, blades area/plant, and LAI formed 0.59, 0.03, 0.17 and 0.47% of the variation, respectively, in addition the joint effect of flag leaf area with 4^{th} leaf area, blades area/plant, and LAI was 0.24, 1.47 and 3.50% of the variation, respectively. Again, the joint effect of 4^{th} leaf area with blades area/plant, and LAI amounted 0.41 and 0.01% of the variation, while, the joint effect of blades area/plant with LAI was 1.22% of the variation.

As mentioned before ear diameter, flag leaf area, number of ears/plant, number of kernels/row, LAI and ear length were the most effective in contributing the kernels yield since the direct effect amounted to 7.80, 5.03, 2.91, 1.54, 1.39 and 1.0% of the variation, respectively, meanwhile the joint effect of ear diameter with flag leaf area, No. of kernels/row, LAI, ears dry wt./plant, No. of ears/plant, ear length and blades area/plant formed 8.37, 4.98, 4.97, 3.08, 2.59, 2.43 and 2.38% of the variation, respectively. On the other hand, the joint effect of flag leaf area with LAI and blades area/plant was 3.50 and 1.47% of the variation, respectively. In addition, the joint effect of No. of ears/plant with flag leaf area, No. of kernels/row, LAI, ears dry wt./plant and blades area/plant were formed 6.11, 3.28, 3.06, 1.78 and 1.24% of the variation, whereas, the joint effect of No. of kernels/row with flag leaf area, LAI and blades area/plant were 4.38, 2.33 and 1.10% of the variation, respectively. Again, the joint effect of blades area/plant with LAI was 1.22% while, the joint of ear length with No. of ears/plant, flag leaf area, No. of kernels/row, ear dry wt./plant and LAI were amounted to 2.88, 2.16, 1.90, 1.78 and 1.68% of the variation, respectively.

Here, it is worthy to mention that those parameters ear diameter, flag leaf area, No. of ears/plant, No. of kernels/row, LAI and ear length could contribute much of white maize kernels yield since R^2 was 100% of the total variation.

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