

Growth and Yield Analysis for Fifteen White Maize (*Zea Mays L.*) Genotypes Developed in Egypt

¹S.E. Sadek, ²M.A. Ahmed and ¹A.M.M. Abd El-Aaal

¹Maize Research Program, Field Crops Research Institute, Agriculture Research Centre, Giza, Egypt.

²Field Crops Research Department, National Research Center, Dokki, Giza, Egypt.

Abstract: In two field experiments were carried out at Gemmeiza (Gharbia governorate) and Sids (Bani Sweif governorate) Agricultural Research Stations in summer season of 2004, eight parental inbred lines, i.e. Gm.2, Gm.4, Gm.14, Gm. 18, Gm.21 Gm.22, Gm.27 and Sd.63, as well as seven Gemmeiza single crosses, i.e. Gm.21, Gm.22, Gm.23, Gm.24, Gm.25, Gm.26 and Gm.27 to study growth and yield analysis in these genotypes. The obtained Results revealed that Significant differences were obtained between the parental inbred lines and their seven maize single crosses under study for all eight of the in growth parameters at 55, 70 and 85 days after planting except for number of active leaves / plant at 55 and 85 days, SLA at 85 days and number of ears / plant at 70 days after planting, which were in significant . Plant grain yield and most of its component characters were significantly differed among the eight inbred lines and their seven single crosses under study. Number of days to 50 % of silking and polling were significantly differed between the fifteen genotypes under study. Harvested maize grain yield can be increased by growing single crosses 21, 24, 25, 26 and 27 that characterized by their highest mean values from growth characters and grain yield and its components compared with the parental eight inbred lines and the other two Gemmeiza single crosses 22 and 23.

Key words: White maize(*Zea mays L.*) genotypes, growth and yield

INTRODUCTION

Genotypes differences in growth characters and grain yield and its components of maize crop may enable plant breeders to select for most promising combiners in their breeding programs. Maize growers can select the good hybrids such as single and three way crosses. Maize cultivars differed in growth characters^[1-10]. In addition, maize genotypes differed in grain yield and its components^[3,4,9-12].

The aim of this work is to investigate growth and yield analysis of eight parental inbred lines as well as their seven single crosses of white maize.

MATERIALS AND METHODS

Fifteen different white maize genotypes were used in this study i.e eight female and male parental inbred lines as well as seven single crosses (see Table 1) .

All of these genetic materials in (Table 1) except male inbred line Sids 63 were developed at Gemmeiza Agricultural Research Station during the period from 1983 to 1995 summer seasons by S.E. Sadek *et al*, national maize breeding program, Field Crops Research Institute (FCRI), Agricultural Research Center (ARC),

Ministry of Agriculture, Egypt. These fifteen genotype were planted in summer season of 2004 at both Agricultural Research Stations, Gemmeiza (Garbia governorate or middle delta region) and Sids (Bani Sweif or middle Egypt region) in crossing Blocks and demonstration fields in two field experiments, Randomized Complete Block Design (RCBD) with six replications. Three replicates were assigned for growth analysis and the others for grain yield and its components. The experimental unit consisted of seven row each of five meters length and 70 cm in width. Maize kernels were planted in hills 25cm apart at a rate of 12 kg/fed. Normal cultural practices of growing maize, i.e. fertilization, irrigation and weed control... etc were done as recommended. Plants were thinned to one plant per hill before the first irrigation. Nitrogen fertilizer rate was 120 kg N/fed. in the form of urea (46 % N) and was applied in two equal doses before the first and second irrigation (21 and 35 days after sowing). Planting dates were 15th June in season of 2004 at both Gemmeiza and Sids Stations, and 18th of respectively. The following growth attributes were recorded on three samples of five guarded plants, each was taken randomly at 55, 70 and 85 days after planting; plant height "cm", stem diameter "cm", number of active leaves/plant, number of ears/plant,

Table 1: Genetic used materials.

Single Cross name	Parents	
	female	male
Gm.21	Gm.2	Sd. 63
Gm.22	Gm.21	Sd.63
Gm.23	Gm.4	Sd. 63
Gm.24	Gm.18	Sd. 63
Gm.25	Gm.14	Sd. 63
Gm.26	Gm.22	Sd. 63
Gm.27	Gm.27	Sd.63

Gemmeiza = (Gm.), Sids = (Sd.)

stem + sheats dry weight “g/plant”, blades dry weight “g/plant”, ears dry weight “g/plant”, 4th leaf blade area “cm²” and blades area “ cm²/plant “ were calculated according to the method described by Bremner and Taha^[13]. Specific leaf weight “ mg/cm²” (SLW) was estimated according to the method described by Pearce *et al*^[14], meanwhile, leaf area index (LAI) was calculated as Watson^[15]. Furthermore, number of days to 50 % silking and plant polling were recorded.

At harvest date, kernels, straw and biological yields per plant, number of ears/plant, ear height “cm”, ears weight/plant “g”, ear length “cm” , ear diameter “ cm “, number of rows/ear, number of kernels/row and 100 kernels weight “g”, were determined from the middle rows of the plot for ten guarded plants. Moreover, Relative Photosynthetic Potential (RPP) for biological and grain yields and vegetative organs were estimated according to the method described by Vidovic and Pokorny^[16]. Again, crop index and harvest index, as well as, migration coefficient were calculated according to Abdel-Gawad *et al.*^[17].

Combined analysis of the two growing seasons data was carried out according to procedure outlined by Snedecor and Cochran^[18]. For comparison between means L.S.D. at 5 % level was used.

RESULTS AND DISCUSSIONS

A- Growth analysis : There were significant differences between the eight parental Gemmeiza inbred lines; Gm.2, Gm.4, Gm.14, Gm.18, Gm.21, Gm. 22, Gm.27 and Sd.63, as well as the seven white Gemmeiza single crosses under study 21, 22, 23, 24, 25, 26 and 27 in growth characters, i.e. plant height, stem diameter, stem + sheets dry weight/plant, blades dry weight/plant, ear dry weight per plant, 4th leaf blade area, blades area/plant, LAI and SLW at 55, 70 and 85 days after planting, as well as, number of plant active leaves at 70 days, number of ears/plant at 85 days, and SLA at 55 and 70 days after sowing (Table 2). Plant height, stem diameter, number of active leaves/plant, blades dry weight/plant, 4th leaf blade area, blades area/cm² and LAI increased up to 70 days after planting and decreased at 85 days after planting, meanwhile, number of ears/plant and ears dry weight/plant tended to increase with advance of age up to

85 days after planting. Data illustrated in Table (2) indicated that SC.24 had the highest maize plant height at 55, 70 and 85 days, plant ears dry weight, blades area per plant and LAI, meanwhile, SC.25 proved to have the greatest mean values from stem diameter, number of active leaves/plant, stem + sheets dry weight/plant, blades dry weight/plant, and 4th leaf blade area, compared with the parental eight inbred lines Gm.2, Gm.4, Gm.14, Gm.18, Gm.21, Gm.22, Gm.27 and Sd.63, as well as the other single crosses. 21, 22, 23, SC.24, 26 and 27 respectively. Regarding number of ears/plant, SLW and SLA we can be concluded that inbred line Gm.18 at 70 days and Gm.14 at 85 days proved to have the greatest values from number of ears/plant, Gm-2 gave the greatest SLW at 55 days, meanwhile, inbred lines Gm.18, Gm.22 produced the highest SLA at 70 days as, compared with other genotypes under study; lines Gm.2, Gm.4, Gm.14, Gm.21, Gm.27, Sd.63, as well as single crosses SC.21, SC.22, SC.23, SC.24, SC.25, SC.26 and SC.27 respectively (Table 2). With respect to number of days to 50 % silking and number of days to 50 % polling, Gm.2, Gm.18 and Sd.63 had the greatest values from these to measurements compared with the other parental inbred lines; Gm.4, Gm.14, Gm.21, Gm.22, Gm.27, as well as the single crosses 21, 22, 23, 24, 25, 26 and 27. (Table 3). The genotypes differences in growth attributes in this study are in harmony with those obtained by Gardner^[11], Beavenuti and Belloni^[2], Ahmed and Sadek^[3], Sadek *et al*^[4], Saneoka^[5], Clarck *et al*^[6], Sundy *et al*^[7] Zaki *et al*^[8], Ahmed and Hassanein^[9] and El-Koomy^[10]. In addition, the differences between maize genotypes herein may be attributed to the photosynthateic activity in the leaves, i.e. internal factor and/or to the differences in light distribution on leaf surface of the crop canopy resulted from differences in leaf arrangement and to the differences in chlorophyll content and photosynthesis enzymes activity^[10,19], to the differences in stomatal conductance values^[10,20].

B- Yield and its components: There were significant differences between the eight parental inbred lines Gm.2, Gm.4, Gm.14, Gm.18, Gm.21, Gm.22, Gm.27, Sd.63 and the seven white Gemmeiza single crosses 21, 22, 23, 24, 25, 26 and SC-27 in plant height, ear height, ear length, ears dry weight/plant, number of kernels/row, 100 kernel weight, grain yield/ plant as well as ; straw and biological yields/plant, RPP_{kr}, RPP_{bio} and RPP_{veg}. (Table 3). On the other hand, the differences in number of ears/plant failed to reach the significant level at 5 %. Moreover, data reported in (Table 3) revealed that the inbred line Gm-2 had the highest value from 100 kernels weight and migration coefficient, among the studied inbred lines meanwhile, Gm-18 gave the greatest RPP_{bio} among the studied lines, whereas, Gm.27, significantly exceeded the other inbred lines Gm.2, Gm.4, Gm.14, Gm.18, Gm.21,

Table 2: Genotypes differences between the parental eight white inbred lines and their seven maize single crosses in growth parameters. (Average of Gemmeiza and Sids location 2004 summer seasons).

Age	Line Gm 2	Line Gm 4	Line Gm 14	Line Gm 18	Line Gm 21	Line Gm 22	Line Gm 27	Line Sd 63	SC 21	SC 22	SC 23	SC 24	SC 25	SC 26	SC 27	L.S.D. at 5% Level
Plant height "cm"																
55	140.00	128.33	153.33	116.67	116.67	98.33	153.33	121.00	201.67	199.17	200.83	218.34	205.00	197.50	204.17	4.61
70	145.00	193.33	162.20	171.17	171.17	192.00	210.00	180.00	257.50	267.50	265.00	293.33	290.00	255.83	274.17	6.02
85	135.00	188.34	151.60	165.00	165.00	180.10	205.00	164.17	247.50	250.00	264.17	275.83	268.34	241.67	266.33	4.25
Stem diameter "cm"																
55	2.23	2.22	2.47	2.47	2.47	2.43	2.33	2.40	2.27	2.40	2.25	2.45	2.90	2.32	2.60	0.02
70	2.60	2.30	2.47	2.67	2.67	2.47	2.70	2.43	2.60	2.60	2.58	2.67	3.17	3.00	3.00	0.04
85	2.14	2.27	2.40	2.38	2.38	2.17	2.58	2.39	2.27	2.27	2.40	2.49	2.67	2.53	2.60	0.03
Number of active leaves/plant																
55	14.00	12.33	14.00	14.00	14.00	12.67	14.00	12.50	16.00	15.33	15.50	15.50	16.67	15.83	16.00	n.s
70	15.00	13.00	15.33	15.33	15.33	13.33	15.33	13.50	17.33	16.67	18.00	18.00	18.33	18.00	18.00	0.33
85	10.67	11.40	12.17	11.67	11.67	11.00	12.84	11.83	12.50	12.00	12.83	13.00	14.00	12.83	13.00	n.s
Number of ears/plant																
55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	1.00	1.00	1.21	2.00	1.00	1.00	1.00	1.00	1.17	1.18	1.03	1.33	1.11	1.05	1.17	n.s
85	1.37	1.21	1.67	1.67	1.25	1.20	1.67	1.00	1.33	1.33	1.19	11.39	1.19	1.17	1.45	0.05
Stem + sheats dry weight "g/plant"																
55	82.00	128.41	131.93	127.67	127.67	133.00	142.50	117.93	144.10	149.73	154.25	152.83	160.80	155.96	149.33	4.52
70	106.67	156.06	175.33	153.33	153.33	140.00	158.67	152.68	159.20	161.00	164.50	162.66	179.00	165.17	160.00	2.82
85	96.67	123.44	130.00	123.33	123.33	100.00	128.50	118.67	133.40	136.40	130.00	134.50	140.00	133.41	136.48	3.14
Blades dry weight "g/plant"																
55	27.33	35.36	31.63	31.33	31.33	31.00	31.00	30.42	34.77	37.58	39.16	41.32	47.26	40.33	44.16	1.20
70	30.43	39.93	36.00	35.90	35.90	35.80	37.17	41.03	40.84	43.37	44.34	48.50	54.67	46.67	50.49	2.56
85	24.24	33.97	27.20	22.03	22.03	22.52	31.01	30.46	36.27	41.19	42.80	43.17	44.10	43.04	43.49	0.48
Ears dry weight "g/plant"																
55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	-	-	26.3	-	18.03	26.67	-	-	64.94	60.00	61.89	70.00	73.33	65.00	72.66	1.72
85	25.00	53.59	63.34	51.67	56.67	56.67	45.00	33.33	86.67	76.67	83.33	96.67	103.34	93.67	96.67	2.86
4th leaf balde area "cm ² "																
55	306.00	375.89	363.55	361.27	450.10	409.80	419.00	450.10	434.72	393.71	427.37	476.44	482.82	477.00	477.68	12.15
70	482.49	544.50	445.90	472.50	578.59	490.78	514.93	501.75	642.00	567.50	551.88	609.55	670.48	606.19	623.47	9.38
85	358.13	450.43	437.19	407.12	480.99	383.43	464.06	463.42	551.04	468.74	494.10	508.66	527.41	498.75	516.68	3.24
Blades area "cm ² /plant"																
55	3427.20	5390.27	4071.76	4046.22	5523.63	4153.73	4692.80	5400.00	5470.34	4828.50	5390.53	6245.8	5907.86	6040.73	6179.27	11.35
70	5703.89	6461.00	5468.52	5794.74	6501.12	5233.68	6315.10	6312.00	7654.26	7568.20	8244.80	9289.7	7938.44	7929.14	8142.56	11.17
85	3821.25	5642.16	4256.48	3800.87	4967.90	3374.84	4766.82	5354.05	6075.55	5396.43	6344.24	6953.4	6599.38	6577.05	6634.17	18.82
Leaf area index																
55	1.96	3.08	2.33	2.31	3.16	2.37	2.68	3.09	3.13	2.76	3.08	3.57	3.37	3.45	3.53	0.01
70	3.26	3.69	3.12	3.31	3.71	2.99	3.61	3.61	4.37	4.32	4.71	5.31	4.54	4.53	4.65	0.03
85	2.18	3.22	2.43	2.17	2.84	1.93	2.72	3.06	3.47	3.08	3.63	3.97	3.77	3.76	3.79	0.06
Specific leaf weight "mg/cm ² "																
55	7.97	6.56	7.77	7.74	5.55	7.66	6.82	5.63	6.63	7.16	7.26	6.99	7.57	6.68	7.15	0.12
70	5.33	6.18	6.58	6.20	5.41	6.84	5.89	5.60	5.34	5.73	5.38	6.11	5.88	5.89	6.20	0.08
85	6.34	6.02	6.39	5.87	6.34	6.67	6.51	5.69	5.97	7.63	6.75	6.54	6.34	6.54	6.56	0.11
Specific leaf area "cm ² /cm ³ "																
55	0.014	0.024	0.015	0.020	0.026	0.024	0.017	0.026	0.016	0.014	0.015	0.016	0.015	0.017	0.016	0.003
70	0.022	0.019	0.020	0.025	0.200	0.023	0.017	0.200	0.017	0.016	0.018	0.015	0.020	0.018	0.016	0.001
85	0.016	0.017	0.014	0.013	0.016	0.013	0.012	0.019	0.014	0.012	0.014	0.014	0.015	0.016	0.013	n.s

Gm.22 and Sd.63 in plant height, ear height, number of ears/plant, ears dry weight/plant, ear length, number of rows/ear, grain yield/plant, straw yield/plant biological yield per plant., RPP_{kr} and RPP_{veg} . On the other hand, Gm.22 characterized by its higher number of kernel/row compared with the other four inbred lines under study. Furthermore, SC.24 significantly out yielded the other

genotypes under this study, i.e. inbred lines Gm.2, Gm.14, Gm.18, Gm.22, Gm.27 and single crosses 21, 22, 23, 24, 26 and 27 in plant grain yield, ears dry weight/plant, number of kernels/row, 100 kernels weight and grain yield/plant and/or fed, straw yield/plant, RPP_{bio}

Table 3: Genotypes differences between parental white maize inbred lines and their seven single crosses in yield and its components (Average of Gemmeiza and Sids locations in summer season of 2004 and 2004 seasons).

Yield and its Components	Gm 2	Gm 4	Gm 14	Gm 18	Gm 21	Gm 22	Gm 27	Sd 63	SC 21	SC 22	SC 23	SC 24	SC 25	SC 26	SC 27	L.S.D. at 5% Level
Plant height "cm"	129.00	178.40	151.50	159.00	170.28	129.00	209.00	139.50	206.50	231.50	256.50	261.50	272.00	260.50	270.55	1.23
Ear height "cm"	64.00	75.00	79.50	89.00	74.50	59.50	116.50	80.00	114.00	124.50	137.50	137.50	143.50	137.50	140.50	1.26
No. Of ears/plant	1.00	1.30	1.30	1.10	1.70	1.00	1.90	1.00	1.10	1.30	1.50	1.10	1.10	1.30	1.50	n.s
Ears dry weight "g/plant"	58.00	98.00	71.00	82.00	99.00	60.00	146.00	95.00	222	164.00	192.00	262	255.00	232.00	260.00	1.86
Ear diameter "cm"	3.30	4.10	4.20	3.60	4.35	3.00	4.10	3.40	4.80	4.41	4.60	4.05	4.39	4.51	4.75	0.18
Ear length "cm"	8.90	13.70	13.50	16.80	14.10	13.50	17.90	10.20	19.00	19.30	19.50	21.50	21.20	19.90	21.67	0.51
No. Of rows/ear	12.20	11.60	10.50	12.30	10.20	13.00	13.20	12.20	14.10	12.40	13.20	14.00	13.80	13.40	13.20	0.19
No. Of kernels/row	14.40	20.40	17.70	17.90	20.00	25.00	15.90	22.20	35.9	26.60	30.70	39.2	37.62	36.98	38.20	0.55
100 kernels weight "g"	34.18	23.90	29.34	33.17	24.44	17.45	25.30	18.42	34.39	25.59	33.21	37.81	35.03	34.70	35.83	0.73
Kernels yield "g/plant"	40.72	97.02	57.00	54.50	93.70	45.90	96.37	85.90	183.4	126.30	146.59	209.85	201.60	186.34	203.74	3.42
Straw yield "g/plant"	94.00	158.00	142.00	194.00	170.00	148.34	214.00	188.00	332.00	312.00	356.00	420	436.00	337.00	434.00	1.80
Biological yield "g/plant"	134.72	255.02	199.00	248.50	263.70	194.24	310.37	273.90	478.59	438.30	539.40	637.60	629.85	523.34	637.74	2.70
Kernel yield "ton/fed"	0.69	1.31	0.97	0.93	1.54	0.78	1.64	0.87	3.12	2.75	2.89	3.57	3.43	3.17	3.46	0.14
Straw yield "ton/fed"	2.088	2.850	2.224	3.298	3.230	2.522	3.638	1.670	5.644	5.304	6.052	6.142	6.140	5.729	6.378	0.160
Biological yield "ton/fed"	2.780	4.160	3.193	4.225	4.770	3.302	5.276	2.540	8.536	8.051	9.170	9.839	9.707	8.897	9.842	0.032
Migration coefficient	0.554	0.420	0.477	0.330	0.390	0.309	0.405	0.440	0.401	0.374	0.412	0.400	0.416	0.443	0.408	0.005
RPP _w "g/ILAI"	18.68	31.80	23.46	25.12	32.99	35.31	35.43	28.07	42.24	41.01	50.52	53.47	52.86	49.56	53.76	0.13
RPP _{no} "g/ILAI"	61.80	83.62	81.89	114.52	92.85	100.64	114.11	61.44	137.92	142.32	148.60	169.12	158.65	139.19	168.27	0.46
RPP _{veg} "g/ILAI"	43.12	51.82	58.43	89.40	59.86	65.33	78.68	33.37	95.68	101.30	98.08	115.65	105.79	89.63	114.51	0.54
No. Of days to 50 % of plant silking	69.50	69.00	61.00	70.00	67.00	67.00	67.50	70.00	61.00	61.00	61.00	61.00	58.50	61.00	62.50	0.92
No. Of days to 50% of plant polling	71.00	67.00	61.00	70.50	66.00	69.00	68.50	71.00	61.00	61.00	61.00	61.00	58.00	60.50	62.00	n.s

and RPP_{veg} mean white, SC.27 exceeded the other genotypes under study in biological yield/plant, straw yield/fed, biological yield/fed. and RPP_{kr}, SC.21 produced the greatest ear diameter, however, however, number of rows/ear, Gm.2 exceeded the other eleven genotypes under this study in migration coefficient.

The results of this study differences in yield and its components may be due to the differences in genetic structure between the fifteen maize genotypes in this study, and to the widely differences between maize genotypes for mineral concentrations^[6], also to the differences in light distribution of leaf surface of the crop canopy resulted from the differences in leaf arrangement and to the differences in chlorophyll content and photosynthesis enzymes activity^[10,19] and the differences in stomatal conductance values^[10,20], in addition, to the differences between genotypes in partitioning of photosynthates towards economic yield^[8,9]. Moreover, the significant superiority of the white maize single crosses 21, 24, 25, 26 and 27 than the other two single crosses 22, 23 may be due to that the highest yielding cultivars had more vigorous system for generation reducing potentials during plant growth than did the less productive genotypes and the higher yielding genotypes had a higher photosynthetic electron transport chain

potential, which is a genetical character, than the lower yielding genotypes^[21]. Again, their greatest number of kernels may be cause of their large yield as such ears are more effective sink for the carbohydrate synthesized in the leaves with fewer and larger kernels^[22].

It is note worthy to mention that the genotypes differences in yield and its components in this study are in harmony with the results obtained by Costa and Campos^[11], Ahmed and Sadek^[3], Sadek *et al*^[4], Begna *et al*^[12], Zaki *et al*^[8], Ahmed and Hassanein^[9] and El-Koomy^[10].

REFERENCES

- Gardner, F.P., V. Alle and D.E. Mc Cloud, 1990. Yield characteristics of ancient roses of maize compared to modern hybrid. *Agron. J.*, 82(5): 864-868.
- Beovenuti, A. and P. Pelloni, 1990. Plant growth and dry matter yield in maize in relation to cultivar and density. *Agric. Mediteranean*, 120(4): 422-428.
- Ahmed, M.A. and S.E. Sadek, 1992. Growth and yield in some maize cultivars (*Zea mays* L.) grown in Egypt. *Egypt. J. Appl. Sci.*, 7(10):328-343.

4. Sadek, S.E., H.Y. Sh. El-Sherbieny, M.A. Ahmed and M.A. Younis (1994). Evaluation of eight yellow maize (*Zea mays* L.) hybrid grown in Egypt. 1- Growth analysis and grain yield components *J. of Agric. Sci., Mansoura Univ.* 19 (12) : 4151-4160.
5. Saneoka, H., 1996. Cultivar differences in dry matter production and leaf water relations in water-stressed maize (*Zea mays* L.) . *J. of Japanese Soc. of Grassland Sci. (Japan)*, 41 (4) : 294-301.
6. Clark, R.B., S.K. Zeto, V.C. Baligar and K.D. Ritchey, 1997. Growth traits and mineral concentrations of maize hybrids grown on unlimed and limed acid soil. *J. of plant Nutr.* 20(12): 1773-1795.
7. Sundy, T., K.R. Vegh and T. Tischner, 1997. Phosphorus response of maize hybrids and their parental lines. *Novenytermeles*, 46(4): 355 - 360.
8. Zaki, N.M., M.M. El-Gazzar, K.M. Gamal El-Din and M.A. Ahmed, 1999. Partition and migration of photosynthates in some maize hybrids. *Egypt. J. Appl. Sci.*, 14 (6) : 117-139.
9. Ahmed, M.A. and M.S. El-S. Hassanein, 2000. Partition of photosynthates in yellow maize hybrids. *Egypt. J. Agron.*, Vol. 22 : 39-63.
10. El-Koomy, M.B.A., 2005. Significance of some agronomic indices in maize breeding program. Ph.D. Thesis, Agron. Dept. Fac. of Agric., Ain Shams Univ.
11. Costa, J.G. and D.A.J.S. Campos, 1990. Maize cultivars recommended for the state of acre . *Counica de Tecnico unidade d'Execuo de Numbito Estand.* No. 56, 4 pp. (c.f. *Field Crop Abst.*, 1991, vol. 44 No. 12).
12. Begna, S.H., R.I. Hamilton, L.M. Dwyer, D.W. Stewart and D.L. Smith, 1997. Effect population density and planting pattern on the yield and yield components of leafy reduced. Stature maize in short season area *Sci., Zeitschrift fur Acker and Plan. J. Agron. and Crop.*, 179(1): 9-17.
13. Bremner, P.M. and M.A. Taha, 1966. Studies in Potato agronomy. 1. The effect of variety, seed size and spacing on growth, development and yield. *J. Agric. Sci.* , 66: 241-252.
14. Pearce, R.B., G.E. Carlson, D. Barmes, R.H. Host and C.H. Hanson, 1969. Specific Leaf weight and photosynthesis in alfalfa. *Crop Sci.* 2: 423-426.
15. Watson, D.J., 1952. The physiological basis of variation in yield. *Adva. Agron.*, 4:101-145.
16. Vidovic, J. and V. Pokorny, 1973. The effect of different sowing densities of nutrient levels in LAI, production and distribution of dry matter in maize. *Glogia Planta*, 15: 374- 382.
17. Abdel-Gawad, A.A., K.A. El-Shouny, S.A. Saleh and M.A. Ahmed, 1987. Partition and migration of dry matter in newly cultivated wheat cultivars. *Egypt. J. Agron.*, 12(1-2): 1-16.
18. Snedecor, G.W. and W.G. Cochran, 1982. "Statistical Methods" Oxford and I.B.H. Publishing. 7th Ed . Iowa State Univ. Press, Iowa, USA.
19. Gwizdek, S., 1989. Role of photosynthesis in some maize lines and their hybrids. *Hodowla Roslin, Aklimatyzacja nasiennictwo*, 33(5-6) : 61-72.
20. Ray, J.D. and T.R. Sinclair, 1997. Stomatal closure of maize hybrids in response to drying soil. *Crop Sci.*, 37 (30) : 803-807
21. Volodarskii, N.I., E.E. Bystrykh and E.K. Nikolaeva, 1978. Photosynthetic activity of the upper leaf of wheat in varieties with different productivity. *S. Kh. Biol.*, 13: 703-710.
22. Fisher, R.A., J. Aguilar and D.R. Laing, 1977. Path analysis sink size in high yielding dwarf wheat: yield response of grain number. *Aust. J. of Agric. Res.*, 28: 165-175.