RESULTS AND DISCUSSION

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FIRSTLY: AGRONOMIC ASPECTS

EFFECT OF PLANTING DATE, VARIETY, NITROGEN LEVEL AND THEIR INTERACTIONS ON GROWTH AND YIELD OF MAIZE.

A- Effect of planting date:

1- Growth characters:

Results in Table 2 show the effect of planting date on some important growth characters of maize in 1991 and 1992 seasons. It is clear that all characters studied, namely, number of leaves/plant, leaf area of topmost ear, leaf area index (L.A.I), plant height, ear height and stem diameter, were significantly affected by planting date in both seasons of experimentation. Early planting on May 1 favourably affected all growth characters compared with medium and late planting in June 1 and July 1, respectively.

The number of functioning leaves/plant was significantly higher with early planting. Delaying planting from May to June and July significantly reduced number of leaves per plant by 10.00% and 15.48%, respectively in the 1991 season. The corresponding reductions were 7.45% and 12.96% in the 1992 season, in the same respective planting dates. Results reported by **Chase and Nada (1967), Yousef (1968), Hamada (1972), Bisher (1973), and Ba-Momen (1981)** indicated that number of leaves per plant significantly increased in early planting.

Similarly, **leaf area of the topmost ear** was markedly reduced as a result of delaying planting date from May to June and July. The reduction reached 15.79% and 23.75% in the 1991 season, being 5.48% and 23.36% in the 1992 season due to delaying May planting to June and July, respectively. Similar results were also obtained by **Hanway (1962), Eik and Hanway (1966), Sprague (1968), Yousef (1968), Hamada (1972), Bisher (1973), Osafo and Milbourn (1975) and**

Table 2: Effect of planting dates on some average growth characters in maize during 1991 and 1992 seasons.

Characters	Planting dates*			Mean	L.S.D 0.05
	May	June	July		
		1991			
Number of leaves per plant	14.99	13.50	12.67	13.72	0.38
Leaf area of topmost ear (cm^2)	763.15	742.67	581.97	662.60	32.78
Leaf area index	8.08	6.16	5.35	6.53	0.43
Plant height (cm)	308.80	283.73	231.87	274.80	13.43
Ear height (cm)	144.40	139.23	114.90	132.84	8.28
Stem diameter (mm)	26.93	22.09	20.51	23.18	1.41
		1992			
Number of leaves per plant	13.97	12.16	12.16	13.02	0.41
Leaf area of topmost ear (cm^2)	717.99	678.69	550.33	649.16	56.45
Leaf area index	7.09	5.89	5.19	6.06	0.40
Plant height (cm)	258.27	239.35	223.60	240.41	16.32
Ear height (cm)	116.88	106.38	98.82	107.36	8.74
Stem diameter (mm)	23.00	22.07	21.65	22.24	0.94

* All characters are significantly different among planting dates.

Ba-Momen (1981) who found that early planting significantly increased leaf area of maize plant.

Concerning **L.A.I**, a significant reduction was also recorded due to delaying the planting date from May to June and July. A reduction in L.A.I of 23.77% and 33.79% in the 1991 season, and of 16.93% and 26.80% in the 1992 season, resulted from delaying maize planting from May to June and July, respectively. These results are in line with those obtained by **Eik and Hanway (1966)** who found that the grain yield tended to be linearly related to L.A.I at silking time.

A similar trend was also recorded for the adverse effects of delaying planting date with regard to **plant height**. Reductions in maize plant height of 8.12% and 24.92% in the 1991 season, and of 7.33% and 13.43% in the 1992 season, were recorded due to delaying planting from May to June and July, respectively. These results are in harmony with those obtained by **Kassem (1964), Chase and Nada (1967), Mahmoud (1967), Abo-Khadrah (1968), Genter and Jones (1970), Bisher (1973), Ba-Momen (1981) and Abdel-Gawad (1986).**

Similarly, **ear height** was significantly reduced as a result of delayed planting. Delaying maize planting from May to June and July reduced ear height by 3.59% and 20.43% in the 1991 season being 8.99% and 15.46% in the 1992 season, respectively. It is clear that July planting caused a very great reduction in this character. The results reported by **Yousef (1968), Ba-Momen (1981), Fakorede (1985), and Abdel-Gawad (1986)** indicated also that late planting tended to lower ear position.

Concerning **stem diameter**, a similar trend for the bad effects of delayed planting was quite evident particularly in the first experimental season. It is clear from Table 2 that delaying maize planting from May to June and July significantly reduced stem diameter by 17.98% and 23.84% in the first season, and 4.04% and 5.87% in the second season, respectively. The result is in line with that of

Mahmoud (1967) and **Ba-Momen (1981)** who reported that stalk diameter decreased when planting date was delayed from May to July.

From the previous results it is clear that the optimum planting date for maize is May followed by June and a serious reduction in maize growth could be expected with a July planting. These results are mainly due to the favourable climatic conditions when maize is planted on the first of May where maize plants will grow in summer season to achieve their maximum growth and to utilize the climatic conditions which are considered as optimal for maize.

It is well known that maize as a short day plant needs an early planting in order to achieve its maximum vegetative growth before the advent of fall season with its short day. In early planting in May, maize plants will achieve better growth and the growing season will extend compared with June and July planting dates. This extension of the growing season contributes in building better plant organs, achieving higher plant growth expressed as number of leaves per plant, leaf area, L.A.I, plant height and stem diameter. In addition, an early maize planting will certainly help maize plants to escape a severe attack with stem boarers which cause serious growth and yield reductions.

2- <u>Ear characters:</u>

Results presented in Table 3 indicate clearly that ear characters, namely, ear length, ear diameter, number of rows/ear and number of kernels/row were significantly affected by maize planting date in both seasons. A marked and consistent reduction was recorded in ear characters with delaying maize planting to June and July. It is quite clear that delaying maize planting until July, seriously reduced ear characters.

Delaying planting from May to June, reduced **ear length, ear diameter, number of rows per ear and number of kernels per row** by 8.07%, 7.83%, 3.00%

Table 3: Effect of planting dates on average ear characters in maize during 1991 and 1992 seasons.

Characters	Planting dates			Mean	L.S.D 0.05
	May	June	July		
		1991			
Ear length (cm)	20.34	18.70	17.39	18.81	1.77
Ear diameter (mm)	51.65	47.61	46.50	48.59	1.65
Number of rows/ear	13.70	13.29	13.08	13.36	0.45
Number of kernels/row	43.36	36.03	30.28	36.56	4.98
		1992			
Ear length (cm)	20.17	19.10	15.44	18.23	2.22
Ear diameter (mm)	47.89	45.95	44.52	46.12	1.74
Number of rows/ear	13.85	13.19	12.69	13.24	0.64
Number of kernels/row	40.16	36.40	29.23	35.26	4.06

and 16.91%, respectively in the 1991 season, being 5.31%, 4.06%, 4.77% and 9.37% in the 1992 season. Further delaying of planting from May to July reduced the four previous ear characters by 14.51%, 9.98%, 4.53% and 30.17%, respectively in the 1991 season, and by 23.46%, 7.04%, 8.38% and 27.22% in the 1992 season. Similar results were also reported by **El-Mankabaty (1967), Mahmoud (1967), Abo-Khadrah (1968), Shah and Sharma (1970), Bisher (1973), Ba-Momen (1981), Fakorede (1985), Abdel-Gawad (1986), Shams (1988)** and **Abo El-Zahab and Rady (1990)** who found that ear characters were greatly reduced due to late planting. It is quite evident that ear characters which are considered as important yield component characters followed the same pattern of response of growth characters to planting date.

The present results are quite expected since growth characters markedly influence ear characters of maize plants. A well developed maize plant with higher number of functioning leaves, a greater leaf area and L.A.I, a greater plant height and stem diameter will certainly produce better ear characters. It could be concluded that early planting will help in producing more vigourous plants with greater ear size.

3- Grain yield and its related characters:

Results presented in Table 4 show clearly that grain yield of maize and its components were markedly affected by planting date in both seasons. Differences among the yield component characters were almost all significant except those among grain yield/fad. in the 1992 season, which failed to reach the 0.05 level of significance.

Results indicated that early planting in May favourably affected **grain yield/plant, shelling percentage and grain index** compared with June and July plantings. In May planting, these three traits outweighed those of June planting by 42.61%, 5.92%, and 7.56% in the 1991 season, respectively, and 40.29%, 2.55%

Table 4: Effect of planting dates on average grain yield and related characters in maize during 1991 and 1992 seasons.

Characters	Planting dates			Mean	L.S.D 0.05
	May	June	July		
		1991			
Grain yield/fad.(kg)	2957.17	2371.60	1686.07	2338.28	879.96
Grain yield/pl. (gm)	232.90	163.31	139.75	178.65	20.65
Shelling percentage	78.36	73.98	68.16	73.50	2.26
Wt.of 100 ker. (gm)	36.96	34.36	33.72	35.01	1.64
		1992			
Grain yield/fad.(kg)	1683.22	1579.98	1185.43	1482.88	n.s
Grain yield/pl. (gm)	190.44	135.74	130.43	152.20	13.60
Shelling percentage	72.73	70.92	70.51	71.38	0.70
Wt. of 100 ker. (gm)	34.89	33.80	29.42	32.70	3.06

and 3.22% in the 1992 season, respectively. Furthermore, these three traits recorded in May planting increased by 66.65%, 14.96% and 9.60% compared with July planting in the 1991 season, respectively. In the 1992 season the increases from the May to July planting were 46.00%, 3.14% and 18.59% for grain yield/plant, shelling percentage and grain index, respectively.

With regard to **grain yield/fad.**, significant differences were quite clear in the 1991 season and the superiority of early planting was clearly demonstrated. On the other hand, in the 1992 season, differences in grain yield/fad. were also noted but were not sufficient to reach the 0.05 level of significance, perhaps due to a higher experimental error, and/or an infestation of stem boarers which adversly affected grain yield which masked a good utilization of the favourable environmental conditions dominating in May and June months. However, May planting outyielded June planting by 24.69% and 6.53% in the first and second season, respectively. Morever, May planting outyielded July planting by 75.38 and 42.00%, in the 1991 and 1992 season, respectively. These results demonstrate clearly that the optimum planting date of maize among those in these trials is early May as far as grain yield is concerned.

Results reported by **Kassem (1964), El-Shafey (1965), Tanaka and Hara (1971), Bisher (1973), Ba-Momen (1981), Fakorede (1985), Abdel-Gawad (1986), El-Shaer *et al* (1987), Shams (1988), Abo El-Zahab and Rady (1990), Albus *et al* (1990) and Nafziger (1994)** also showed that early planting significantly increased grain yield and its components.

These results are quite expected since early planting favourably affected growth characters, ear characters and all grain yield components as previously discussed.

B- <u>Effect of variety:</u>

Two varieties were tested in the present study. The first is Giza 2, a

composite variety whose use is widespread and covers an area of about 400,000 faddans, more than 20% of the total maize area in Egypt. (Agric. Economics, 1989). The other variety is Three Way Cross 310 (T.W.C. 310) which is considered one of the best maize hybrids grown in Egypt.

1- Growth characters:

Results presented in Table 5 show clearly that the two tested varieties significantly differed in all studied traits, namely, number of leaves per plant, leaf area of the topmost ear, L.A.I, plant height, ear height and stem diameter. In both season, T.W.C. 310 was significantly superior compared with Giza 2 in all characters.

The results clearly showed that in the 1991 season, T.W.C. 310 surpassed Giza 2 by 8%, 8.17%, 12.52%, 3.71%, 7.86% and 11.11%, concerning **number of leaves per plant, leaf area of topmost ear, L.A.I, plant height, ear height and stem diameter,** respectively. In the 1992 season, T.W.C. 310 significantly surpassed Giza 2 by 5.52% in number of leaves per plant, by 10.43% in leaf area of topmost ear, by 16.04% in L.A.I, by 3.39% in plant height, by 10.41% in ear height and by 12.01% in stem diameter. These results indicate clearly that T.W.C. 310 was superior compared with the composite variety Giza 2, that the three way cross is more vigorous than the composite variety Giza 2 and that marked differences are mainly due to the differences in the genetical constitution of both varieties.

Similar results were also reported by many investigators who found marked differences among other tested varieties in their growth characters (**Eraky *et al*, 1980; Ba-momen, 1981; Hussein *et al*, 1983; El-Hattab *et al*, 1985; Mourad *et al*, 1986; Gouda, 1989; Nigem, 1989; Moustafa, 1990; El-Bialy *et al*, 1991 and Gouda *et al*, 1992).** Results reported by **Gouda *et al* (1992)** indicated that T.W.C. 310 was significantly superior than the composite variety Giza 2 in all vegetative

Table 5: Effect of varieties on some average growth characters in maize during 1991 and 1992 seasons.

Characters	Varieties*		Mean	L.S.D 0.05
	Giza 2	T.W.C 310		
		1991		
Number of leaves/plant	13.51	13.94	13.73	0.40
Leaf area of topmost ear(cm^2)	636.58	688.61	662.60	22.75
Leaf area index	6.15	6.92	6.54	0.17
Plant height (cm)	269.80	279.80	274.80	3.48
Ear height (cm)	127.82	137.87	132.85	5.04
Stem diameter (mm)	21.96	24.40	23.18	1.08
		1992		
Number of leaves/plant	12.67	13.37	13.02	0.11
Leaf area of topmost ear (cm^2)	616.82	681.20	649.01	26.73
Leaf area index	5.61	6.51	6.06	0.23
Plant height (cm)	236.40	244.42	240.41	7.43
Ear height (cm)	102.05	112.67	107.36	3.96
Stem diameter (mm)	20.98	23.50	22.24	0.57

*All comparisons between Giza 2 and T.W.C. 310 are significant at 0.05.

growth characters.

2- Ear characters:

Results in Table 6 show the ear characters of the two tested maize varieties in the 1991 and 1992 seasons. Results indicated clearly that the two varieties differed significantly at the 0.05 level in all tested traits, namely, ear length, ear diameter, number of rows/ear and number of kernels/row in both seasons with one exception for ear diameter in 1992 where the difference was not significant.

Results showed that **ear length** of T.W.C. 310 was significantly higher by 12.06% and 15.35% in the first and second season, respectively. With regard to **ear diameter**, an opposite trend was observed, where Giza 2 surpassed T.W.C. 310 by 4.16% and 1.07% in the 1991 and 1992 season respectively. Similarly, **number of rows/ear** of Giza 2 surpassed that of T.W.C. 310 by 9.57% and 9.00% in the first and second season, respectively. Concerning **number of kernels/row**, T.W.C. 310 surpassed significantly Giza 2 by 20.74% and 19.31% in the 1991 and 1992 seasons, respectively.

These results indicate clearly that T.W.C. 310 possesses longer ears and consequently greater number of kernels/row. On the other hand, Giza 2 has greater ear diameter and consequently higher number of rows/ear. These results reflect the great differences in the genetical make up of the two tested varieties. Similar results were also reported by many investigators who found marked differences among the evaluated varieties in ear chrarcters **(Eraky *et al*, 1980; Ba-momen, 1981; Hussein *et al*, 1981; Gouda, 1982; Khalifa *et al*, 1983; El-Hattab *et al*, 1985; Nigem, 1989; Moustafa, 1990; El-Bialy *et al*, 1991 and Gouda *et al*, 1992).** The bulk of these studies indicated the superiority of hybrids over the open pollinated varieties in ear characters.

Table 6: Effect of varieties on average ear characters in maize during 1991 and 1992 seasons.

Characters	Varieties		Mean	L.S.D 0.05
	Giza 2	T.W.C 310		
		1991		
Ear length (cm)	17.74	19.88	18.81	0.50
Ear diameter (mm)	49.58	47.60	48.59	1.69
Number of rows/ear	13.97	12.75	13.36	0.49
Number of kernels/row	33.12	39.99	36.56	1.11
		1992		
Ear length (cm)	16.93	19.53	18.23	0.78
Ear diameter (mm)*	46.37	45.88	46.13	n.s
Number of rows/ear	13.81	12.67	13.24	0.33
Number of kernels/row	32.16	38.37	35.27	1.07

* The difference between varieties is not significant at 0.05.

3- Grain yield and its related characters:

Results in Table 7 show that both tested varieties differed in grain yield/fad. as well as grain yield/plant in both seasons.

In the 1991 season, Giza 2 was slightly higher than T.W.C. 310 by 6.11%. This result indicates the superiority of Giza 2 over T.W.C. 310 in regard to **grain yield/fad**.

The superiority of Giza 2 over T.W.C. 310 in 1991 season is due probably to the superiority of Giza 2 in ear diameter and number of rows/ear. This result is in line with that obtained by **Bedeer (1984), El-Hattab *et al* (1985) and Matta (1986)** who found that grain yield of maize variety Giza 2 surpassed D.C. Pioneer 514 and Cairo 1 (a composite variety). Also **Ahmed (1989)** demonstrated that Giza 2 outyielded D.C. 202, T.W.C. 4141 and Pioneer 3147 in regard to grain yield/fad.

In the 1992 season, T.W.C. 310 outyielded Giza 2 by 13.57%. This result which contradicts the 1991 finding indicates the superiority of T.W.C. 310 over the composite variety Giza 2 in regard to grain yield/fad. Similar results were also reported by **Ba-Momen (1981), Gouda (1982), Khalifa *et al* (1983), Nigem (1989) and Gouda (1992)**, who found that hybrid maize varieties outyielded open pollinated varieties.

It is worth mentioning here that the composite variety Giza 2 is an open-pollinated variety and its genetical constitution is heterogenous, and its performance in regard to grain yield may accidentally exceed a three way cross. Also the environmental conditions in the first season may interact positively with Giza 2 leading to a higher grain yield. Also, the average yield here is combined over the three planting dates, and the performance of Giza 2 in the late planting was evident compared with T.W.C. 310.

Similarly, the **grain yield/plant** of T.W.C. 310 significantly surpassed that of

Table 7: Effect of varieties on average grain yield and related characters in maize during 1991 and 1992 seasons.

Characters	Varieties		Mean	L.S.D 0.05
	Giza 2	T.W.C 310		
		1991		
Grain yield/fad (kg)	2407.60	2268.90	2338.25	137.04
Grain yield/plant (gm)	169.85	187.45	178.65	5.88
Shelling percentage*	73.64	73.36	73.50	n.s
Wt.of 100 kernels* (gm)	34.86	35.16	35.01	n.s
		1992		
Grain yield/fad (kg)	1388.70	1577.10	1482.90	86.09
Grain yield/plant (gm)	141.95	162.45	152.20	11.41
Shelling percentage*	70.86	71.90	71.38	n.s
Wt.of 100 kernels (gm)	31.79	33.61	32.70	1.03

* The differences between varieties are not significant at 0.05.

Giza 2 by 10.36% and 14.44% in the 1991 and 1992 seasons, respectively.

The superiority of grain yield/plant of the hybrids over the open pollinated and composite varieties has been indicated by several investigators (**Eraky *et al*, 1980; Hussein *et al*, 1980; Ba-Momen, 1981; Gouda, 1982; Khalifa *et al*, 1983; Nigem, 1989; Moustafa, 1990; El-Bialy *et al*, 1991; Mohamed *et al*, 1991 and Gouda *et al*, 1992**). They proved in their investigation a definite superiority of maize hybrids over local open pollinated varieties. The investigation of **Gouda *et al* (1992)** showed the superiority of T.W.C. 310 over Giza 2 in grain yield/plant.

Concerning **shelling percentage**, no significant difference was detected between the two varieties in both seasons. Slight differences were seen in favour of Giza 2 in the 1991 season, but of T.W.C. 310 in the 1992 season. The results reported by **Hussein *et al* (1980), Gouda (1982) and Mohamed *et al* (1991)** indicated the superiority of maize hybrids in shelling percentage over the open-pollinated varieties, whereas **El-Agamy *et al* (1986)** reported no significant differences among D.C. 202 and Giza 2 in shelling percentage. Also **El-Hattab *et al* (1985)** found the shelling percentage of Giza 2 surpassed that of Cairo 1 and D.C. Pioneer 514.

The **weight of 100 kernels** of T.W.C. 310 was higher than that of Giza 2 with a significant difference of 5.73% in the 1992 season only. Similar results were also reported by **Khalifa *et al* (1983), Amer (1984), Moustafa (1990), Mohamed *et al***

(1991) who found that hybrids were of higher grain index than open-pollinated varieties, whereas **El-Hattab *et al* (1985)** found that 100-kernel weight of Giza 2 was greater than that of Cairo 1 and D.C. 202 Pioneer 514.

It could be concluded that T.W.C. 310 is a high yielding maize variety compared with the composite variety Giza 2 under the optimum growth conditions..

C- Effect of nitrogen fertilizer level:

1- Growth characters:

Results presented in Table 8 show the effect of nitrogen (N) level on growth characters of maize. Levels of N used were 30, 60, 90, 120, 150 kg/fad. Results showed that the increase in N level from 30 to 150 had no significant effect on all characters studied except leaf area of topmost ear in the 1992 season.

With regard to **leaf area of the topmost ear**, increasing N level from 30 to 60, 90, 120, 150 kg/fad. significantly increased leaf area in the 1992 season only. The increase in leaf area was 4.13%, 9.24%, 4.60% and 9.17% with the increase in N level from 30 to 60, 90 120, 150 kg N/fad., respectively. The highest leaf area was recorded with the N level of 90 kg/fad. In the 1991 season, the increase in N level had no significant effect on this character. Similar results were also reported by **Salem (1973), Shafshak *et al* 1981), Faisal (1983), Wali *et al* (1985), Khedr (1986), Ashoub *et al* (1987), Gouda (1989) and Gouda *et al* (1992).** On the other hand **Mohamed (1986)** found that increasing N level did not increase significantly leaf area.

The **number of leaves per plant** showed no significant differences among the five N levels in both seasons, which indicates that this character is mainly governed by the genetical constitution of the variety and is rarely affected by the environmental factors or soil conditions. However, results reported by **Salem (1973),**

Table 8: Effect of nitrogen fertilizer levels on some average growth characters in maize during 1991 and 1992 seasons.

Characters	Nitrogen levels (Kg/fad)					Mean	L.S.D* 0.05
	30	60	90	120	150		
				1991			
Number of leaves/plant	13.54	13.71	13.72	13.94	13.69	13.72	n.s
Leaf area of topmost ear (cm^2)	678.74	658.89	651.42	653.10	670.83	662.60	n.s
Leaf area index	6.68	6.51	6.41	6.50	6.56	6.53	n.s
Plant height (cm)	278.94	277.33	274.56	270.28	272.89	274.80	n.S
Ear height (cm)	134.33	129.61	132.89	131.50	135.89	132.84	n.s
Stem diameter (mm)	23.46	22.91	23.24	22.91	23.38	23.18	n.s
				1992			
Number of leaves/plant	12.88	12.99	13.19	12.88	13.15	13.02	n.s
Leaf area of topmost ear (cm^2)	615.59	641.00	672.47	643.90	672.06	649.00	31.50
Leaf area index	5.69	5.89	6.35	5.96	6.39	6.06	0.40
Plant height (cm)	240.21	241.37	239.25	241.29	239.92	240.41	n.s
Ear height (cm)	106.58	103.79	110.50	106.17	109.75	107.36	n.s
Stem diameter (mm)	22.20	21.74	22.33	22.20	22.73	22.24	.n.s

* The differences among N levels are not significant for all growth characters in both seasons except for leaf area of the topmost ear and L.A.I in the 1992 season.

Eraky et al (1982), Gouda (1982), Faisal (1983), Wali *et al* (1985) and Khalil (1992) indicated that the increase in N level significantly increased number of leaves per plant.

Similarly, **L.A.I** was not significantly affected by the increase in N level in spite of a slight increase in the 1992 season. However, results reported by **Attia (1980), Wali *et al* (1985), Salih and Wali (1988) and Ahmed (1989)** indicated a significant increase in L.A.I due to the increase in N level.

Also, **plant height, ear height and stem diameter** were not significantly affected by N level in both seasons of experimentation indicating that a level of 30 kg N was quite satisfactory to achieve a good growth of maize plants under the conditions of the experiments, that any further increase over this level showed no marked effect on these traits. Similar results were also reported by **Abdel-Gawad *et al* (1974), Attia (1980) and Younis *et al* (1990)** who found that the increase in N level did not significantly affect plant height of maize. On the other hand, **Salem (1973), Al-Rudha and Al-Younis (1978), Abdel-Gawad (1986), Mohamed (1986), Ahmed (1989b) and Khalil (1992)** reported that the increase in N level significantly increased plant height of maize.

2- <u>Ear characters:</u>

Results presented in Table 9 show the effect of nitrogen level on ear characters of maize plant. It is clear that, in general, the increase in nitrogen level increased most of the ear characters in both seasons. The increases in ear diameter in the 1991 season as well as in ear length and number of kernels/row in the 1992 season reached the level of significance, whereas the increases recorded in number of rows/ear were not significantly different in both seasons.

Increasing nitrogen level from 30 to 60, 90, 120 and 150 kg increased **ear length** by 3.72%, 1.13%, 1.24% and 0.65%, respectively in the 1991 season. The

Table 9: Effect of nitrogen fertilizer levels on average ear chararcters in maize during 1991 and 1992 seasons.

Characters	Nitrogen levels (kg/fad)					Mean	L.S.D* 0.05
	30	60	90	120	150		
				1991			
Ear length (cm)	18.56	19.25	18.77	18.79	18.68	18.81	n.s
Ear diameter (mm)	48.73	48.74	48.77	49.16	47.56	48.59	1.10
Number of rows/ear	12.98	13.67	13.29	13.49	13.36	13.36	n.s
Number of kernels/row	36.81	36.41	37.41	36.08	36.09	36.56	n.s
				1992			
Ear length (cm)	17.03	18.00	18.49	18.63	19.02	18.23	1.08
Ear diameter (mm)	45.53	45.55	46.42	46.53	46.57	46.12	n.s
Number of rows/ear	13.12	13.05	13.24	13.33	13.47	13.24	n.s
Number of kernels/row	32.81	34.14	36.10	36.08	37.18	35.26	2.64

* The differences among N levels are not significant for ear length in the 1991 season, ear diameter in the 1992 season, number of rows/ear in the 1991 and 1992 seasons and number of kernels/row in the 1991 season.

corresponding increases in the 1992 season were 5.70%, 8.57%, 9.40% and 11.69%, respectively. Similar results were also obtained by **Al-Rudha and Al-Younis (1978), Salem *et al* (1982), Salwau (1985), Abdel-Gawad (1986), Mohamed (1986), Panchanathan *et al* (1987), Nimje and Seth (1988) and Khalil (1992)** who found that the increase in N level significantly increased ear length. On the other hand, results reported by **Shafshak *et al* (1981) and Younis *et al* (1990)** showed that the increase in N level did not induce a significant increase in ear length.

Regarding **ear diameter**, increasing N level from 30 to 60, 90, 120 and 150 kg/fad. increased this trait by 0.02%, 0.08%, 0.88% and (-2.40%) in the 1991 season, respectively. In the 1992 season, the increases in ear diameter were 0.04%, 1.95%, 2.20% and 2.28% for the same respective N levels, which however were not statistically significant. Results reported by **Salem *et al* (1982), Salwau (1985), Abdel-Gawad (1986), Khedr (1986), and Mohamed (1986)** indicated a significant increase in ear diameter due to an increase in N level. Whereas **Abdel-Gawad *et al* (1974)** reported no significant increase in this character with an increase in N level.

Number of rows/ear showed no significant response to the increase in N level in both seasons. Similar results were also reported by **Abdel-Gawad *et al* (1974), Salem *et al* (1982), Salwau (1985), Abdel-Gawad (1986)** who found no significant response in number of rows/ear due to an increase in N level. On the other hand, **Salem (1973), Al-Rudha and Al-Younis (1978), Mohamed (1986) and Abo El-Zahab and Rady (1990)** found a significant increase in this trait due to an increase in N level.

Number of kernels/row increased significantly in the 1992 season by 4.05%, 10.03%, 9.97% and 13.32% when the N level increased from 30 to 60, 90, 120 and 150 kg/fad., respectively. This result showed a marked response of this character to

N level in the second season, however it was not significant in the 1991 season. Mixed results were also reported in the literature: **Salem (1973), Attia (1980), Faisal (1983), Khedr (1986), Younis *et al* (1990)** indicated a significant response of number of kernels/row to the increase in N level whereas **Abdel-Gawad *et al* (1974), Shafshak *et al* (1981), and Salem *et al* (1982)** found no significant increase in this character due to the increase in N level.

It could be concluded that the increase in N level from 30 to 60, 90, 120 and 150 kg/fad. favourably affected ear characters particularly ear length, ear diameter and number of kernels/row.

3- Grain yield and its related characters:

Results in Table 10 indicate that **the grain yield** of maize per fad. was significantly affected by N level in both seasons. In the 1991 season, increasing N level from 30 to 60, 90, 120 and 150 kg/fad. increased grain yield by 8.27%, 22.55%, 11.70% and 16.58%, respectively. In the 1992 season, the N levels increased grain yield/fad. by 17.45%, 38.26%, 32.00% and 43.97%, respectively, compared with the 30 kg N/fad. level. The highest grain yield was obtained at a level of 90 kg N/fad. in the first season and a level of 150 kg N/fad. in the second season, but without significant difference compared with the 90 kg N/fad. level. This suggests that under the conditions of the experiment a level of 90 kg N/fad. is quite a satisfactory level of N as far as grain yield/fad. is concerned.

The increased yield findings are mainly due to the favourable effect of a higher N level on growth characters such as leaf area and ear characters such as ear length, ear diameter and number of kernels/row. Similar results were also obtained by **Salem (1973), Abdel-Gawad *et al* (1974), Ali (1976), Verma and**

Table 10: Effect of nitrogen fertilizer levels on average grain yield and related characters in maize during 1991 and 1992 seasons.

Characters	Nitrogen levels (kg/fad)					Mean	L.S.D* 0.05
	30	60	90	120	150		
				1991			
Grain yield/fad (kg)	2100.78	2274.53	2520.47	2346.56	2449.07	2338.28	204.89
Grain yield/plant (gm)	181.84	178.10	181.69	176.38	175.24	178.65	n.s
Shelling percentage	72.68	73.39	74.12	74.29	73.03	73.50	n.s
Wt.of100-kernerls (gm)	35.04	35.63	34.96	35.03	34.42	35.02	n.s
				1992			
Grain yield/fad (kg)	1173.74	1378.54	1622.85	1549.33	1689.88	1482.87	163.26
Grain yield/plant (gm)	135.55	147.87	158.56	161.60	157.43	152.20	19.35
Shelling percentage	70.86	71.32	71.20	71.55	71.98	71.38	n.s
Wt.of100-kernels (gm)	32.62	32.41	32.66	33.34	32.48	32.70	n.s

* The differences among N levels are not significant at 0.05 except for grain yield/fad in the 1991 season and 1992 season and grain yield/plant in the 1992 season.

Singh (1976), Al-Rudha and Al-Younis (1978), Satyanaryava *et al* (1978), Attia (1980), Knapp and Reid (1981), Salem *et al* (1982), Fox and Piekielek (1983), Singh *et al* (1984), Patel *et al* (1985), Abdel-Gawad (1986), Panchanathan *et al* (1987) Abo El-Zahab and Rady (1990), Mannino *et al* (1990) and Khalil (1992) who found a marked increase in maize grain yield due to the increase in N level.

Also, increasing the N level positively affected **grain yield/plant** and slightly increased shelling percentage. Consequently, an increase in grain yield/fad. is quite expected. Results showed that the effect of increasing N level was only significant in the second season, where raising the N level from 30 to 60, 90, 120 and 150 kg N/fad. markedly increased grain yield/plant by 9.09%, 16.98%, 19.22% and 16.14%, respectively. In the first season, the increase in N level failed to show any effect on this trait.

The significant response of grain yield/plant to N level was also reported by **Attia (1980), Salem *et al* (1982), Salwau (1985), Abdel-Gawad (1986), Nimje and Seth (1988), Abo El-Zahab and Rady (1990) and Khalil (1992).**

Neither **shelling percentage** nor **grain index** were significantly affected by N level in either seasons of experimentation. Shelling percentage was slightly increased in both seasons due to the increase in N level. Increasing N level from 30 to 60, 90, 120 and 150 kg N/fad. increased shelling percentage by 0.98%, 1.98%, 2.22% and 0.48%, respectively in the 1991 season. The corresponding increases for the same N levels were 0.64%, 0.47%, 0.79% and 1.58% in the 1992 season. All these increases were, however, below the level of significance. Similar results were also reported by **Salem (1973), Salem *et al* (1982) and Mohamed (1986)**, whereas **Abdel-Gawad (1986) and Ashoub *et al* (1987)** found a significant increase in shelling percentage due to the increase in N level.

Similarly, **weight of 100 kernels** was slightly increased in the 1992 season but without any significant difference. Similar results were also obtained by **Kouraim**

***et al* (1980), and Salwau (1985)** who found no significant increase in grain index due to the increase in N level. On the other hand, **Salem (1973), Attia (1980), Salem *et al* (1982), Abdel-Gawad (1986), Mohamed (1986), Ashoub *et al* (1987), Nimje and Seth (1988) and Khalil (1992)** found a significant response of 100-kernel weight to the increase in N level.

It can reasonably be concluded that a level of 90 kg N/fad. was quite satisfactory under the conditions of the present study. The lack of response to the higher N levels may be due to an excess reserve of N in the soil from the residual effect of the preceding crop, which was Egyptian clover in both seasons, and the previous supply of organic and mineral fertilizers.

D- Interaction Effects:

1- Interaction between planting date and varieties:

The analysis of varaince showed that in the 1991 season, plant height, number of kernels/row and yield of grains were significantly affected by the interaction between planting date and varieties, and in the 1992 season, number of leaves/plant, stem diameter, number of kernels/row and weight of grains/plant were significantly affected by this interaction.

Results in Table 11 and Figure 1 show the effect of planting date X varieties on **number of leaves/plant** in the 1992 season (P=0.02) where it is clear that the difference in this character between the tested varieties was more evident under the June planting, but this difference is diminished under early as well as under late planting. These results showed clearly that T.W.C. 310 was suprior compared with the composite variety Giza 2, that the three way cross is more vigorous than the composite variety and that marked differences are mainly due to the differences in the genetic constitution of both varieties. The highest value of this trait was 14.25 recorded with T.W.C. 310 planted in May and the lowest number of leaves/plant was

Table 11: Average number of leaves/plant in the 1992 season showing the interaction (P = 0.02) between planting dates and varieties.

Planting dates	Varieties		Mean
	Giza 2	T.W.C. 310	
May	13.69	14.25	13.97
June	12.46	13.40	12.93
July	11.86	12.45	12.15
Mean	12.67	13.37	13.02

L.S.D (0.05) = 0.19 for horizontal comparisons

L.S.D (0.05) = 0.10 for remaining

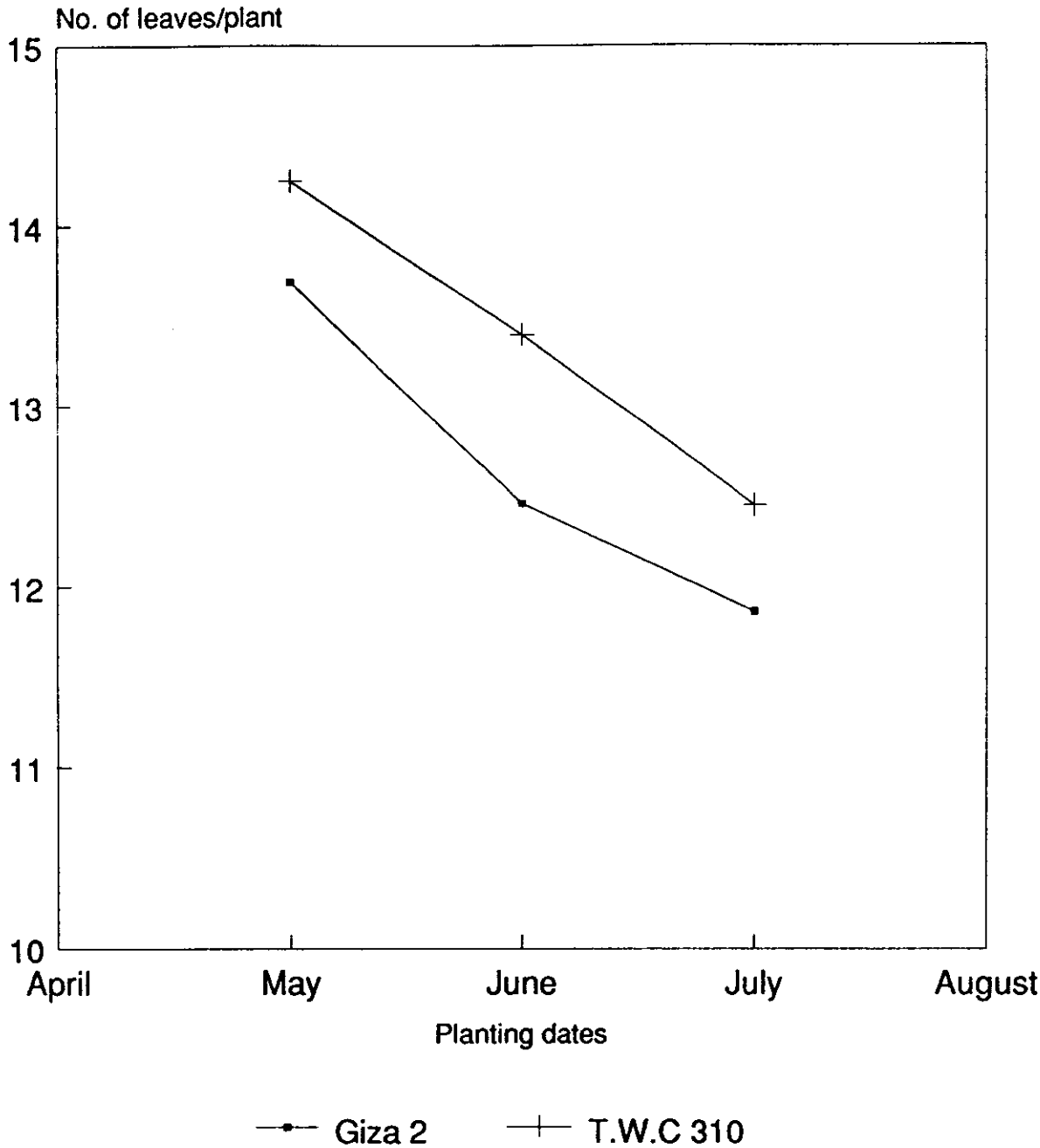
Table 12: Effect of the interaction (P = 0.001) between planting dates and varieties on plant height (cm) in 1991 season.

Planting dates	Varieties		Mean
	Giza 2	T.W.C. 310	
May	308.60	309.00	308.80
June	271.47	296.00	283.73
July	229.33	234.40	231.87
Mean	269.80	279.80	274.80

L.S.D (0.05) = 6.02 for horizontal comparison.

L.S.D (0.05) = 14.10 for remaining.

(Fig.1): Dates X varieties interaction
No. of leaves/plant in the 1992 season



11.86 recorded with Giza 2 planted in July.

Plant height in the 1991 season was significantly affected by this interaction (P=0.001) where the significant difference in this character between varieties was only observed under the June planting, whereas under May and July plantings no significant differences were observed between both varieties. This result indicates that T.W.C. 310 plants performed well with a June planting. The maximum plant height of 309.00 cm was recorded with T.W.C. 310 planted in May and the shortest height was 229.33 cm recorded with Giza 2 in July planting, (Table 12).

With **stem diameter**, results in Table 13 showed that planting date X varieties significantly (P=0.001) affected this trait in the 1992 season. Under early planting the difference in stem diameter was greater between varieties than under late planting. The greatest stem diameter was 28.53 mm recorded with T.W.C. 310 under May planting, and the smallest diameter was 19.60 mm of Giza 2 planted in July. **Ba-Momen (1981)** reported different results where the interaction between planting date and variety on this character was not significant.

Results in Tables 14 and 15 indicate that in both seasons, **number of kernels/row** was significantly affected by planting date X varieties. P value was 0.02 and 0.04 in the 1991 and 1992 seasons, respectively. Results showed that the greatest difference between Giza 2 and T.W.C. 310 in this trait in both seasons was observed under June planting being 32.68% and 24.83% in the 1991 and 1992 season, respectively. But under early as well as late planting this difference was greatly reduced. In both seasons, the greatest number of kernels/row was recorded under the May planting with T.W.C. 310 being 46.71 and 43.34 in 1991 and 1992, respectively. The lowest number of kernels/row was produced by Giza 2 under July planting, being 28.39 and 27.11, in the first and second season, respectively. **Ba-Momen (1981)** found no significant effect for planting date X varieties on this character.

Table 13: Effect of the interaction (P = 0.001) between planting dates and varieties on stem diameter (mm) in the 1992 season.

Planting dates	Varieties		Mean
	Giza 2	T.W.C. 310	
May	25.33	28.53	26.93
June	20.93	23.25	22.09
July	19.60	21.43	20.51
Mean	21.95	24.40	23.18

L.S.D (0.05) = 0.98 for horizontal comparison.

L.S.D (0.05) = 1.17 for remaining.

Table 14: Effect of the interaction (P = 0.02) between planting dates and varieties on number of kernels/row in 1991 seeason.

Planting dates	Varieties		Mean
	Giza 2	T.W.C. 310	
May	40.01	46.71	43.36
June	30.97	41.09	36.03
July	28.39	32.16	30.28
Mean	33.12	39.99	36.56

L.S.D (0.05) = 1.92 for horizontal comparison.

L.S.D (0.05) = 5.17 for remaining.

Table 15: Effect of the interaction (P = 0.04) between planting dates and varieties on number of kernels/row in 1992 season.

Planting dates	Varieties		Mean
	Giza 2	T.W.C. 310	
May	36.99	43.34	40.16
June	32.38	40.42	36.40
July	27.11	31.34	29.23
Mean	32.16	38.37	35.26

L.S.D (0.05) = 1.86 for horizontal comparison.

L.S.D (0.05) = 4.27 for remaining.

Table 16: Effect of the interaction (P = 0.03) between planting dates and varieties on grain yield/plant (gm) in 1992 season.

Planting dates	Varieties		Mean
	Giza 2	T.W.C. 310	
May	173.72	207.16	190.44
June	137.27	134.21	135.74
July	114.87	145.99	130.43
Mean	141.95	162.45	152.20

L.S.D (0.05) = 19.76 for horizontal comparison.

L.S.D (0.05) = 14.93 for remaining.

Results in Table 16 indicate a significant effect (P = 0.02) of the interaction between planting date and varieties on **grain yield/plant** in the 1992 season. The greatest difference between the two tested varieties, recorded under July planting, of 29.09% whereas under June planting no significant difference was recorded. Even the better variety T.W.C. 310 produced lower grain yield/plant in June than Giza 2 by 2.28%. Results reported by **Ba-Momen (1981)** indicated no significant effect for planting date X varieties on this trait.

Concerning **grain yield/fad.**, results in Table 17 showed that a significant interaction effect (P=0.03) was recorded between planting date and variety in the 1991 season. Results showed that Giza 2 outyielded T.W.C. 310 under early planting (May) as well as late planting (July), whereas under the intermediate planting (June) T.W.C. 310 slightly outyielded Giza 2, showing evidence for the interaction effect. In general, the highest grain yield/fad. was 3091.94 kg/fad. which was obtained by Giza 2 under May planting, and the lowest grain yield was 1543.73 kg/fad. produced by T.W.C. 310 in July planting. Results reported by **Gilmore and Rogers (1959), Killinger *et al* (1959), Grogan *et al* (1959), Kassem (1964) and Ba-Momen (1981)** indicated a significant effect for planting date X varieties on grain yield of maize, whereas **El-Ebrashy (1959), and Aboul-Ela and Kassem (1962)** found no significant effect.

2- <u>Interaction between planting date and N level:</u>

The effect of the interaction between planting date and N level was significant (P=0.004) on leaf area of topmost ear in the 1992 season, ear length in both seasons (P=0.02), ear diameter in the 1991 season (P=0.03), yield of grain/plant in the 1991 season (P=0.003), grain index in the 1991 season (P=0.03) and yield of grains/fad in both seasons(P=0.00, 0.004).

Results in Table 18 show that **leaf area of the topmost ear** was significantly

Table 17: Effect of the interaction (P = 0.03) between planting dates and varieties on grain yield/fad. (Kg) in 1991 season.

Planting dates	Varieties		Mean
	Giza 2	T.W.C. 310	
May	3091.94	2822.40	2957.17
June	2302.53	2440.67	2371.60
July	1828.40	1543.73	1686.07
Mean	2407.62	2268.93	2338.28

L.S.D (0.05) = 237.36 for horizontal comparison.

L.S.D (0.05) = 895.82 for remainig.

Table 18: Effect of the interaction (P = 0.004) between planting dates and nitrogen fertilizer on leaf area of topmost ear (cm^2) in 1992 season.

Planting dates	Nitrogen levels (kg/fad)					Mean
	30	60	90	120	150	
May	649.65	748.08	764.20	702.64	725.41	717.99
June	693.03	662.75	681.33	682.21	674.14	678.69
July	504.10	512.19	571.89	646.85	616.64	550.33
Mean	615.59	641.00	672.47	643.90	672.06	649.00

L.S.D (0.05) = 54.70 for horizontal comparison.

L.S.D (0.05) = 74.60 for remaining.

Table 19: Effect of the interaction (P = 0.002) between planting dates and nitrogen fertilizer on ear length (cm) in 1991 season.

Planting dates	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
May	19.45	21.09	20.42	19.45	21.30	20.34
June	17.97	19.27	19.07	19.47	17.74	18.70
July	18.27	17.40	16.84	17.47	17.00	17.39
Mean	18.56	19.25	18.77	18.79	18.68	18.81

L.S.D (0.05) = 1.19 for horizontal comparison.

L.S.D (0.05) = 2.05 for remaining.

affected by the interaction between planting date and N level in the 1992 season. In general, higher response to an increase in N level was observed in early planting. The highest leaf area in the 1992 season was 764.20 cm^2 resulting from a May planting supplied with 90 kg N/fad. and the lowest area was 504.10 cm^2 recorded with the July planting supplied with 30 kg N/fad.

Ear length was significantly affected by planting date X N level in both seasons as shown in Tables 19 and 20. In the 1991 season, significant differences were observed between May and July planting under the N levels of 60, 90 and 150 kg N/fad. On the other hand, there were no significant differences between early and intermediate planting under the N levels used in the present study. In the 1992 season, it is evident that there were significant differences between May and July planting under the five studied N levels, whereas no significant differences were observed between early and late planting. It is observed that maximum values of ear length were 21.30 cm in 1991 and 21.25 cm in 1992 which were obtained from May planting date supplied with 150 and 90 kg N/fad. in the first and second season, respectively. The lowest ear length was 16.84 cm in the 1991 season recorded with July planting and 90 kg N/fad., whereas in the 1992 season the combination of July planting and 30 kg N/fad. produced the shortest ears having 14.10 cm length.

Regarding **ear diameter**, results in Table 21 showed that planting date X N level significantly affected this character in the 1991 season. The greatest diameter was 52.25 mm which was the result of combining the May planting with 60 kg N/fad., and the smallest diameter was 45.27 mm recorded from the July planting with 30 kg N/fad.

Results in Table 22 showed also that a significant interaction effect of planting date and N level was detected on **grain yield/plant** in the 1991 season. It is clear that this character showed higher response to N level under June planting, whereas under early planting (May) as well as late planting (July) the increase in N

Table 20: Effect of the interaction (P = 0.03) between planting dates and nitrogen fertilizer on ear length (cm) in 1992 season.

Planting dates	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
May	18.96	21.00	21.25	19.98	19.63	20.17
June	18.00	18.55	19.63	19.58	19.75	19.10
July	14.10	14.45	14.60	16.35	17.68	15.44
Mean	17.03	18.00	18.49	18.63	19.02	18.23

L.S.D (0.05) = 1.86 for horizontal comparison.

L.S.D (0.05) = 2.77 for remaining.

Table 21: Effect of the interaction (P = 0.03) between planting dates and nitrogen fertilizer levels on ear diameter (mm) in 1991 season.

Planting dates	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
May	51.55	52.25	51.87	51.48	50.77	51.66
June	49.37	47.90	46.73	47.57	46.50	47.61
July	45.27	46.07	47.70	48.07	45.40	46.50
Mean	48.73	48.74	48.77	49.16	47.56	48.59

L.S.D (0.05) = 1.90 for horizontal comparison.

L.S.D (0.05) = 2.36 for remaining.

Table 22: Effect of the interaction (P = 0.003) between planting dates and nitrogen fertilizer on grain yield/plant (gm) in 1991 season.

Planting dates	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
May	243.22	237.14	236.10	213.02	235.00	232.90
June	148.55	154.55	172.02	183.28	158.13	163.31
July	153.75	142.62	136.97	132.83	132.59	139.75
Mean	181.84	178.10	181.69	176.38	175.24	178.65

L.S.D (0.05) = 19.68 for horizontal comparison.

L.S.D (0.05) = 27.03 for remaining.

Table 23: Effect of the interaction (P = 0.03) between planting dates and nitrogen fertilizer levels on weight of 100 kernels (gm) in 1991 season.

Planting dates	Nitrogen fertilizer (kg/fad.)					Mean
	30	60	90	120	150	
May	37.77	37.88	38.03	35.15	35.97	36.96
June	34.98	35.60	32.35	34.77	33.93	34.36
July	32.37	33.40	34.32	35.17	33.35	33.72
Mean	35.04	35.63	34.96	35.03	34.42	35.02

L.S.D (0.05) = 2.44 for horizontal comparison

L.S.D (0.05) = 2.36 for remaining.

level did not induce any increase in the yield of grain/plant over the lowest N level (30 kg N/fad.). Results showed that the highest grain yield/plant was 243.22 gm obtained from May planting with 30 kg N/fad. and the lowest yield was 132.59 gm recorded with the July planting with 150 kg N/fad.

Results in Table 23 showed also that a significant interaction effect was observed for planting date and N level on **100-grain weight** in the 1991 season. The highest grain index was 38.03 gm which was recorded with combining the May planting with 90 kg N/fad., and the lowest index was 32.37 gm obtained from the July planting with 30 kg N/fad.

The grain yield/fad. was significantly affected by the interaction between planting date and N level in both seasons of experimentation as shown in Tables 24 and 25. The maximum grain yield in the 1991 season was 3643.73 kg/fad. which was produced by combining May planting with 90 kg N/fad. level, and the lowest yield was 1561.00 kg produced in July and supplied with 60 kg N/fad. In the 1992 season, the May planting supplied with 150 kg N/fad. produced the highest grain yield per fad. which was 1848.00 kg, whereas July planting with 60 kg N/fad. produced the lowest yield.

3- Interaction between varieties and N level:

The interaction between varieties and N level had a significant effect on the number of leaves/plant in the 1992 season (P=0.03), plant height in the 1992 season (P=0.02), stem diameter in the 1991 season (P=0.01) and grain yield/fad. in the 1992 season (P=0.01).

Results in Table 26 show that **the number of leaves/plant** was significantly affected by the interaction between varieties and N level in the 1992 season. Results show that the response of the hybrid variety, T.W.C. 310, to N fertilizer differed from that of the composite variety, Giza 2. Number of leaves/plant of T.W.C.

Table 24: Effect of the interaction (P = 0.004) between planting dates and nitrogen fertilizer on grain yield/faddan (Kg) in 1991 season.

Planting dates	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
May	2468.67	2975.92	3643.73	2566.67	3130.90	2957.18
June	2020.67	2286.67	2258.67	2751.00	2541.00	2371.60
July	1813.00	1561.00	1659.00	1722.00	1675.33	1686.07
Mean	2100.78	2274.53	2520.47	2346.56	2449.08	2338.28

L.S.D (0.05) = 354.88 for horizontal comparison.

L.S.D (0.05) = 933.89 for remaining.

Table 25: Effect of the interaction (P = 0.004) between planting dates and nitrogen fertilizer on grain yield/faddan (Kg) in 1992 season.

Planting dates	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
May	1486.10	1757.00	1818.30	1506.00	1848.00	1683.23
June	1207.50	1554.40	1783.30	1631.00	1723.70	1579.98
July	827.60	824.20	1267.00	1510.20	1498.00	1185.40
Mean	1173.73	1378.53	1622.87	1549.33	1689.90	1482.87

L.S.D (0.05) = 282.78 for horizontal comparison.

L.S.D (0.05) = 721.07 for remaining.

310 did not show any significant response to N level, whereas Giza 2 variety showed significant differences in this trait due to the N level. Number of leaves/plant of Giza 2 increased significantly as the N level increased up to 90 kg N/fad, however, T.W.C. 310 increased up to 60 kg N/fad. Results showed that the greatest number of leaves/plant was 13.53 recorded with T.W.C. 310 supplied with 60 kg N/fad., and the smallest number was 12.45 recorded with Giza 2 combined with 60 kg N/fad.

Varieties X N level interaction significantly affected maize **plant height** in the 1992 season (Table 27). The maximum plant height was 249.75 cm obtained by T.W.C. 310 supplied with 120 kg N/fad. and the shortest plants were those of Giza 2 supplied with 120 kg N/fad. which has a height of 232.83 cm.

Stem diameter of maize plants was significantly affected by varieties X N level interaction in the 1991 season (Table 28). Clearly the response of T.W.C. 310 plants to N level was significant where some differences in stem diameter were recorded, whereas no significant differences were observed in stem diameter of Giza 2 plants due to N levels factor. The greatest diameter was 25.02 mm recorded with T.W.C. 310 supplied with 30 kg N/fad., and the smallest diameter was 21.56 mm recorded with Giza 2 plants supplied with 90 kg N/fad.

The results presented in Table 29 and Figure 2 show clearly the significant effect of varieties X N level on **the grain yield/fad.** in the 1992 season. It is evident that the significant differences between the two varieties were only observed at higher N levels, namely, 120 and 150 kg N/fad., whereas at lower N levels no significant differences were observed in the grain yield between the tested varieties. The results showed that the hybrid variety, T.W.C. 310, highly responded to the N fertilizer than the composite variety, Giza 2. Grain yield of T.W.C. 310 increased significantly as the N level increased up to 150 kg N/fad, however, Giza 2 showed an increase up to 90 kg N/fad. These results indicate clearly that T.W.C. 310

Table 26: Effect of the interaction (P = 0.03) between varieties and nitrogen fertilizer on number of leaves/plant in 1992 season.

Varieties	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
Giza 2	12.52	12.45	12.98	12.52	12.88	12.67
T.W.C 310	13.23	13.53	13.40	13.25	13.42	13.37
Mean	12.88	12.99	13.19	12.88	13.15	13.02

L.S.D (0.05) = 0.31 for horizontal comparison.

L.S.D (0.05) = 0.48 for remaining.

Table 27: Effect of the interaction (P = 0.02) between varieties and nitrogen fertilizer on plant height (cm) in 1992 season.

Varieties	Nitrogen level (kg/fad.)					Mean
	30	60	90	120	150	
Giza 2	237.83	233.83	243.08	232.83	234.42	236.40
T.W.C 310	242.58	248.92	235.42	249.75	245.42	244.42
Mean	240.21	241.37	239.25	241.29	239.92	240.41

L.S.D (0.05) = 11.22 for horizontal comparison.

L.S.D (0.05) = 12.60 for remaining.

Table 28: Effect of the interaction (P = 0.01) between varieties and nitrogen fertilizer on stem diameter (mm) in 1991 season.

Varieties	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
Giza 2	21.89	21.77	21.56	22.78	21.80	21.96
T.W.C 310	25.02	24.07	24.93	23.04	24.96	24.40
Mean	23.46	22.92	23.25	22.91	23.38	23.18

L.S.D (0.05) = 1.33 for horizontal comparison.

L.S.D (0.05) = 1.71 for remaining.

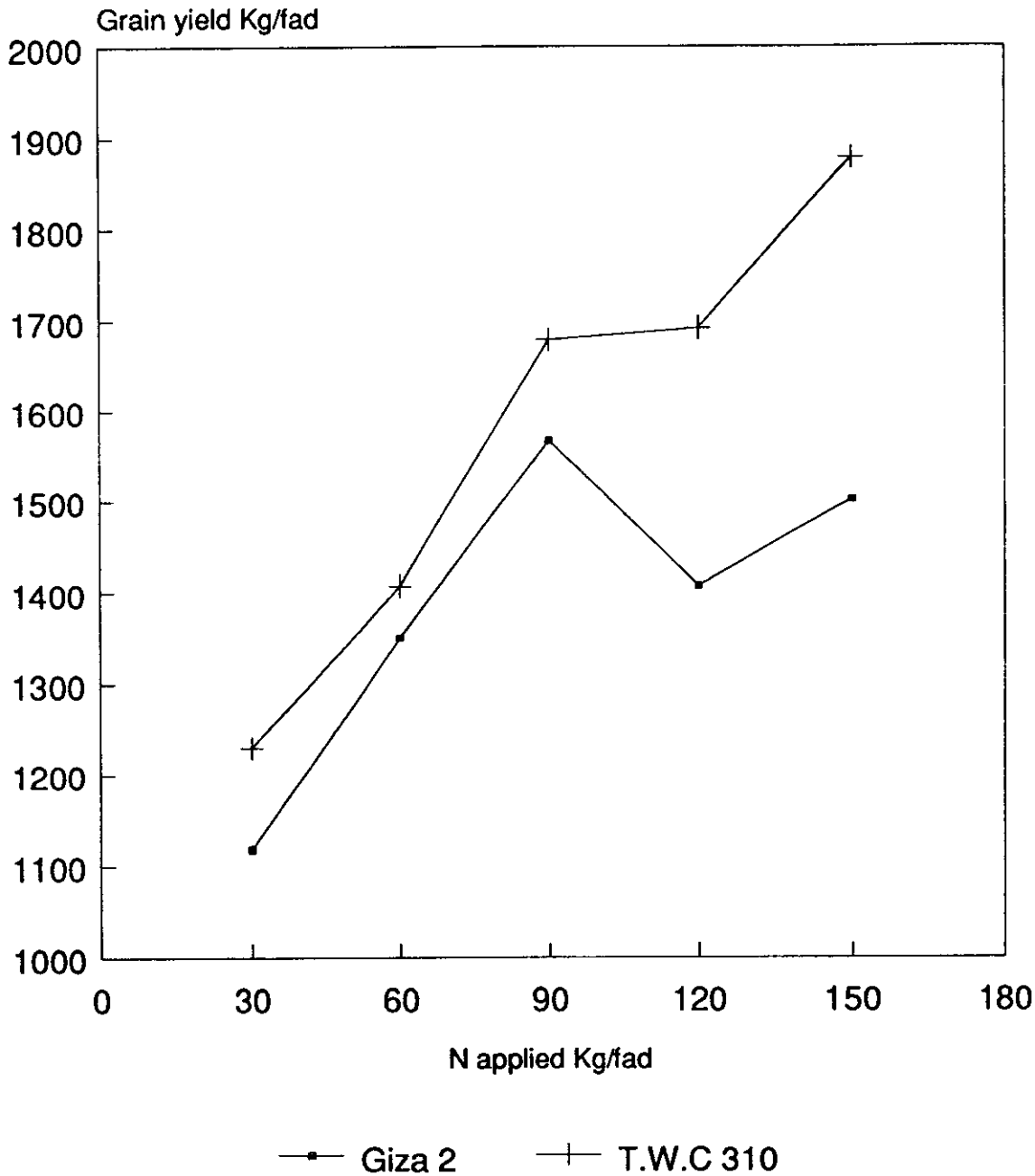
Table 29: Effect of the interaction (P = 0.011) between varieties and nitrogen fertilizer on grain yield/faddan (Kg) in 1992 season.

Varieties	Nitrogen levels (kg/fad.)					Mean
	30	60	90	120	150	
Giza 2	1117.80	1350.10	1566.90	1407.00	1501.50	1388.70
T.W.C 310	1229.70	1407.00	1678.80	1691.70	1878.30	1577.10
Mean	1173.75	1378.55	1622.85	1549.35	1689.90	1482.90

L.S.D (0.05) = 141.67 for horizontal comparison.

L.S.D (0.05) = 223.60 for remaining.

(Fig.2): Varieties X N interaction
Grain yield in 1992 season



surpassed Giza 2 , that the three way cross variety was more responsive to N fertilizer than the composite variety, Giza 2, and that differences are mainly due to the superiority of T.W.C. 310 over Giza 2 in all growth characters and yield components. The highest grain yield was 1878.30 kg/fad. which was produced by T.W.C. 310 supplied with 150 kg N/fad., and the lowest yield was 1117.80 kg/fad. produced by Giza 2 supplied with 30 kg N/fad. Results reported by **Balko and Russell (1980), Kapur and Rana (1980), Singh *et al* (1980) and Singh *et al* (1984)** indicated a significant effect of varieties X N level on maize grain yield.

4- <u>The effect of the three way interaction:</u>

Results presented in Tables 30, 31 and 32 show that the interaction between the three experimental factors had a significant effect ($P < 0.05$) on stem diameter, number of kernels/row and grain yield/fad. in the 1992 season only. Other characters in the 1992 season and all characters in the 1991 season were not significantly affected by the second order interaction, consequently, the data were excluded.

Results in Table 30 show that the greatest **stem diameter** in the 1992 season was 24.90 mm which was recorded with the combination of T.W.C. 310 planted in May and supplied with 30 kg N/fad. Figure 3 shows the 3-way interaction by displaying the 2-way interactions between planting date and N level on the differences between varieties.

The average **number of kernels/row** in the 1992 season was 47.50 recorded with T.W.C. 310 planted in May and supplied with 150 kg N/fad. (Table 31).

The highest **grain yield/fad.** in the 1992 season was 2149.00 kg which was recorded with T.W.C. 310 planted on May and supplied with 150 kg N/fad., and the lowest yield was 759.25 kg/fad. obtained from Giza 2 planted in July and given 30 kg N/fad. (Table 32).

Table 30: Effect of the 3-way interaction (P = 0.05) between planting dates, varieties and nitrogen fertilizer on stem diameter (mm) in 1992 season.

Planting dates	Varieties	Nitrogen levels (kg/fad.)					Mean
		30	60	90	120	150	
May	Giza 2	21.90	22.50	23.30	22.95	23.45	22.82
	T.W.C 310	24.90	22.80	21.65	23.85	22.70	23.18
	Mean	23.40	22.65	22.47	23.40	23.08	23.00
June	Giza 2	18.63	20.20	20.70	20.90	21.75	20.43
	T.W.C 310	24.40	22.80	24.45	22.30	24.55	23.70
	Mean	21.51	21.50	22.57	21.60	23.15	22.06
July	Giza 2	20.15	18.65	20.05	19.95	19.65	19.69
	T.W.C 310	23.25	23.45	23.85	23.25	24.25	23.61
	Mean	21.70	21.05	21.95	21.60	21.95	21.65
Mean	Giza 2	20.22	20.45	21.35	21.26	21.61	20.98
	T.W.C 310	24.18	23.01	23.31	23.13	23.83	23.49
	Mean	22.20	21.73	22.33	22.20	22.72	22.23

L.S.D (0.05) = 1.99 for horizontal comparison.

L.S.D (0.05) = 2.13 for remaining.

(Fig.3): Dates X N interaction
Stem diameter in the 1992 seasn

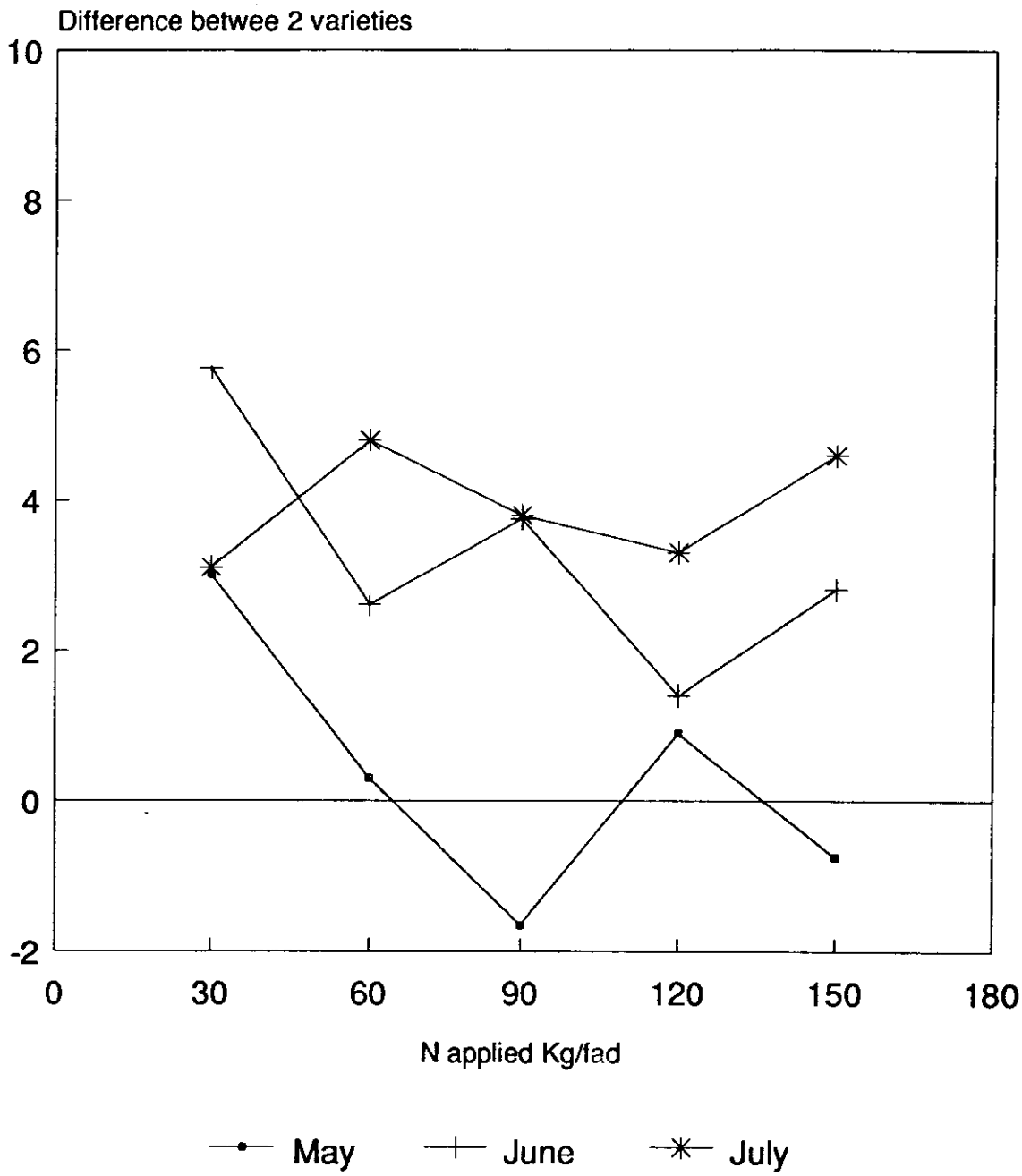


Table 31: Effect of the 3-way interaction (P = 0.03) between planting dates, varieties and nitrogen fertilizer on number of kernels/row in 1992 season.

Planting dates	Varieties	Nitrogen levels (kg/fad.)					Mean
		30	60	90	120	150	
May	Giza 2	34.70	37.75	41.10	37.90	33.50	36.99
	T.W.C 310	37.25	45.65	44.00	42.28	47.50	43.34
	Mean	35.98	41.70	42.55	40.09	40.50	40.16
June	Giza 2	28.10	31.75	33.75	32.15	36.15	32.38
	T.W.C 310	40.10	39.30	39.60	41.95	41.15	40.42
	Mean	34.10	35.53	36.68	37.05	38.65	36.40
July	Giza 2	26.45	24.00	26.20	28.45	30.45	27.11
	T.W.C 310	30.25	26.40	31.95	33.75	34.35	31.34
	Mean	28.35	25.20	29.08	31.10	32.40	29.23
Mean	Giza 2	29.75	31.17	33.68	32.83	33.37	32.16
	T.W.C 310	35.87	37.12	38.52	39.33	41.00	38.37
	Mean	32.81	34.14	36.10	36.08	37.18	35.26

L.S.D (0.05) = 5.07 for horizontal comparison.

L.S.D (0.05) = 6.22 for remaining.

Table 32: Effect of the 3-way interaction (P = 0.01) between planting dates, varieties and nitrogen fertilizer on grain yield/faddan (Kg) in 1992 season.

Planting dates	Varieties	Nitrogen levels (kg/fad.)					Mean
		30	60	90	120	150	
May	Giza 2	1512.70	1736.00	1764.00	1543.50	1547.00	1620.64
	T.W.C 310	1459.50	1778.00	1872.50	1470.00	2149.00	1745.80
	Mean	1486.10	1757.00	1818.25	1506.75	1848.00	1683.22
June	Giza 2	1081.50	1512.75	1683.58	1263.50	1564.50	1421.17
	T.W.C 310	1333.50	1596.00	1883.00	1998.50	1883.00	1738.80
	Mean	1207.50	1554.38	1783.29	1631.00	1723.75	1579.98
July	Giza 2	759.25	801.50	1253.00	1414.00	1393.00	1124.15
	T.W.C 310	896.00	847.00	1281.00	1606.50	1603.00	1246.70
	Mean	827.63	824.25	1267.00	1510.25	1498.00	1185.43
Mean	Giza 2	1117.82	1350.08	1566.86	1407.00	1501.50	1388.65
	T.W.C 310	1229.67	1407.00	1678.83	1691.67	1878.33	1576.97
	Mean	1173.74	1378.54	1622.85	1549.33	1689.92	1482.88

L.S.D (0.05) = 245.38 for horizontal comparison.

L.S.D (0.05) = 717.91 for remaining.

Summary of the interaction effects:

An overall view on the interaction effects in both 1991 and 1992 season is presented in Tables 33 and 34. It is clear from these Tables that, except as noted, the best combinations of planting date and varieties was that of May planting and T.W.C. 310 where the highest values were seen for number of leaves/plant, leaf area, L.A.I, plant height, ear height, stem diameter, ear length, number of kernels/row, shelling percentage and grain yield/plant. In the 1991 season, exceptions were given only with ear diameter where the highest value was recorded with Giza 2 and May planting, number of rows/ear which was recorded with Giza 2 and June planting, weight of 100 kernels which was obtained from Giza 2 and May planting and grain yield/fad. which was recorded with Giza 2 and May planting. In the 1992 season, exceptions were observed with stem diameter (June planting and T.W.C. 310), ear diameter (May planting and Giza 2), number of rows/ear (May planting and Giza 2) and shelling percentage (May planting and Giza 2).

Concerning planting date X N level, the highest values were obtained in general, by combining May planting and a level of 150 , 120 or 90 kg N/fad. in the 1991 season, whereas in the 1992 season, combining May planting with each of 90, 120 or 150 kg N/fad. levels produced the highest values.

Varieties X N level interaction indicated that the best results were obtained from combining T.W.C. 310 with 150 kg N/fad. level particularly in the second season.

The second order interaction also indicated the superiority of May planting combined with T.W.C. 310 and a N level from 90 to 150 kg N/fad. over the lower levels. The best results were obtained from planting in May with T.W.C. 310 and 150 kg N /fad. as far as grain yield/fad. is concerned.

Table 33: Highest response value, significance, and combination of factors of the interaction effects on the studied characters of maize in 1991 season.

Characters	Interactions			
	Dates X Var.	Dates X N	Var. X N	Dates X Var. X N
Number of leaves/plant	15.29 N.S May,T.W.C 310	15.23 N.S May, 150	14.09 N.S T.W.C 310, 60	15.40 N.S May,T.W.C 310,150
Leaf area of topmost ear (cm^2)	781.67 N.S May,T.W.C 310	782.53 N.S May, 150	714.63 N.S T.W.C 310, 150	814.43 N.S May,T.W.C 310,150
Leaf area index	8.52 N.S May,T.W.C 310	8.25 N.S May, 150	7.14 N.S T.W.C 310, 30	8.77 N.S May,T.W.C 310,150
Plant height (cm)	309.00 * May,T.W.C 310	316.83 N.S May, 60	285.33 N.S T.W.C 310, 30	320.00 N.S May, Giza 2, 60
Ear height (cm)	149.47 N.S May,T.W.C 310	150.17 N.S May, 150	140.67 N.S T.W.C 310, 150	153.33 N.S May,T.W.C 310,120
Stem diameter (mm)	28.53 N.S May,T.W.C 310	27.83 N.S May, 150	25.02 N.S T.W.C 310, 30	30.67 N.S May,T.W.C 310,150
Ear length (cm)	21.94 N.S May,T.W.C 310	21.30 * May, 150	20.49 N.S T.W.C 310, 60	22.87 N.S May,T.W.C 310,150
Ear diameter (mm)	52.55 N.S May, Giza 2	52.25 * May, 60	50.89 N.S Giza 2, 120	53.47 N.S May,Giza 2, 120

Table 33: Continued.

Characters	Interactions			
	Dates X Var.	Dates X N	Var. X N	Dates X var. X N
Number of rows/ear	14.07 N.S June, Giza 2	14.00 N.S May, 150	14.42 N.S Giza 2, 120	14.67 N.S May, Giza 2, 150
Number of kernels/row	46.71* May,T.W.C 310	43.57 N.S May, 90	40.66 N.S T.W.C 310, 90	48.27 N.S May,T.W.C 310, 30
Shelling percentage	79.11 N.S May,T.W.C 310	80.05 N.S May, 120	74.53 N.S Giza 2, 90	81.13 N.S May,T.W.C 310,120
Weight of 100 kernels (gm)	37.28 N.S May, Giza 2	38.03* May, 90	36.75 N.S T.W.C 310, 60	39.27 N.S May, Giza 2, 90
Grain yield/plant (gm)	241.03 N.S May,T.W.C 310	243.22 N.S May, 30	194.97 N.S T.W.C 310, 150	256.00 N.S May,T.W.C 310, 30
Grain yield/faddan (kg)	3091.9* May, Giza 2	3643.70* May, 90	2638.80 N.S Giza 2, 90	3730.50 N.S May, Giza 2, 90

Table 34: Highest response value, significance, and combination of factors of the interaction effects on the studied characters of maize in 1992 season.

Characters	Interactions			
	Dates X Var.	Dates X N	Var. X N	Dates X Var. X N
Number of leaves/plant	14.25 * May,T.W.C 310	14.30 N.S May, 150	13.53 * T.W.C 310, 60	14.55 N.S May,T.W.C 310,150
Leaf area of the topmost ear (cm^2)	747.52 N.S May,T.W.C 310	764.20 N.S May, 90	707.07 N.S T.W.C 310,150	799.12 N.S May,T.W.C 310, 60
Leaf area index	7.56 N.S May,T.W.C 310	7.58 N.S May, 120	6.90 N.S T.W.C 310,150	8.08 N.S May,T.W.C 310, 60
Plant height (cm)	259.65 N.S May,T.W.C 310	263.25 N.S May, 120	249.75 * T.W.C 310,120	270.75 N.S May,T.W.C 310, 60
Ear height (cm)	124.20 N.S May,T.W.C 310	123.12 N.S May, 30	113.83 N.S T.W.C 310,120	130.75 N.S May,T.W.C 310, 30
Stem diameter (mm)	23.70 * June,T.W.C 310	23.40 N.S May, 30	24.18 N.S T.W.C 310, 30	24.90 * May,T.W.C 310, 30
Ear length (cm)	21.26 N.S May,T.W.C 310	21.25 * May, 90	20.17 N.S T.W.C 310,150	23.30 N.S May,T.W.C 310, 60
Ear diameter (mm)	47.95 N.S May, Giza 2	48.38 N.S May, 120	47.17 N.S Giza 2, 150	48.65 N.S May, Giza 2, 90

Table 34: Continued.

Characters	Interactions			
	Dates X Var.	Dates X N	Var. X N	Dates X Var. X N
Number of rows/ear	14.47 N.S May, Giza 2	14.05 N.S May, 90	14.13 N.S Giza 2, 150	14.80 N.S May,Giza 2, 90
Number of kernels/row	43.34 * May,T.W.C 310	42.55 N.S May, 90	41.00 N.S T.W.C 310,150	45.60 * May,T.W.C 310,60
Shelling percentage	72.85 N.S May, Giza 2	73.39 N.S May, 150	72.76 N.S T.W.C 310,150	74.30 N.S June,T.W.C 310,30
Weight of 100 kernels (gm)	36.02 N.S May,T.W.C 310	36.40 N.S May, 120	34.46 N.S T.W.C 310,60	37.90 N.S May,T.W.C 310,120
Grain yield/plant (gm)	207.16 * May,T.W.C 310	212.84 N.S May, 90	172.28 N.S T.W.C 310,120	225.77 N.S May,T.W.C 310,60
Grain yield/fad. (kg)	1745.8 N.S May,T.W.C 310	1848.00 N.S May, 150	1878.30 * T.W.C 310,150	2149.00 * May,T.W.C 310,150

SECONDLY: STATISTICAL ASPECTS

MULTIVARIATE AND RESPONSE CURVE ANALYSES FOR IMPORTANT YIELD FACTORS IN MAIZE.

A- Response curve analysis:

Profitability of maize production is affected by selecting the appropriate level of nitrogen fertilizer. Decisions concerning optimal levels of fertilization involve fitting some type of continuous response model to the yield response data collected when several levels of fertilizer are applied. Comparisons among the response functions, linear plus plateau, quadratic and quadratic plus plateau (described in the Materials and Methods section) were based on the mean square error. The model with least mean square error was considered to be the best model fitted to the yield data.

Mean square error for the three models for grain yield per faddan of maize varieties, Giza 2 and T.W.C. 310, planted in May, June and July during the 1991 and 1992 seasons are presented in Table 35. The regression equations are shown in Table 36, and the curves are given in figures (4-15).

In the 1991 season, data for May planting indicate clearly that the best model fitted to the grain yield of variety Giza 2 was quadratic plus plateau, the Mean Square Error for this model was less than those of the other two models. The nitrogen fertilizer rate was 91 kg/fad. at the point of the plateau (Fig.4). This result is in agreement with that obtained by **Fox and Piekielek (1983 and 1990) and Cerrato and Blackmer (1990).** They found that the quadratic plus plateau model was the best of the response models tested for describing maize grain yield response to nitrogen fertilization. We conclude that the quadratic plus plateau model worked well for describing response of grain yield per faddan to nitrogen fertilization. The plateau yield was similar to maximum yield, 3,334.9 kg/fad.

For the June planting, it is clear from Table 35 that the least mean square

Table 35: Mean square error for models, linear plus plateau, quadratic and quadratic plus plateau for grain yield of maize varieties during 1991 and 1992 seasons.

Planting dates	Varieties	Linear + plateau	Quadratic	Quadratic + plateau
		1991		
May	Giza 2	436,127	429,410	409,014
	T.W.C 310	480,764	490,808	461,194
June	Giza 2	127,677	140,132	140,229
	T.W.C 310	304,692	331,334	331,334
July	Giza 2	196,826	205,798	197,010
	T.W.C 310	108,043	86,164	93,924
		1992		
May	Giza 2	368,770	385,571	368,770
	T.W.C 310	310,608	325,154	315,793
June	Giza 2	97,182	112,561	97,165
	T.W.C 310	196,247	188,600	189,498
July	Giza 2	156,625	118,915	118,916
	T.W.C 310	238,090	177,108	177,109

Table 36: Regression equations of maize varieties planted in May, June and July during 1991 and 1992 seasons.

Planting dates	Varieties	Regression equations	X_0	Models
		1991		
May	Giza 2	$Y = 1191.27 + 47.040 X - 0.2581 X^2$	91	Quadratic + plateau
	T.W.C 310	$Y = 2778.00 + 0.560 X$	60	Linear + plateau
June	Giza 2	$Y = 1930.00 + 4.657 X$	110	Linear + plateau
	T.W.C 310	$Y = 1660.60 + 9.751 X$	110	Linear + plateau
July	Giza 2	$Y = 1795.00 + 0.418 X$	110	Linear + plateau
	T.W.C 310	$Y = 2273.00 - 20.200 X + 0.11 X^2$		Non - estimable
		1992		
May	Giza 2	$Y = 1378.00 + 4.500 X$	60	Linear + plateau
	T.W.C 310	$Y = 1102.00 + 11.900 X$	60	Linear + plateau
June	Giza 2	$Y = 657.00 + 14.200 X$	60	Linear + plateau
	T.W.C 310	$Y = 825.00 + 18.300 X - 0.0736 X^2$	124	Quadratic
July	Giza 2	$Y = 352.00 + 12.200 X - 0.0331 X^2$	150	Quadratic
	T.W.C 310	$Y = 586.00 + 7.500 X - 0.0014 X^2$	150	Quadratic

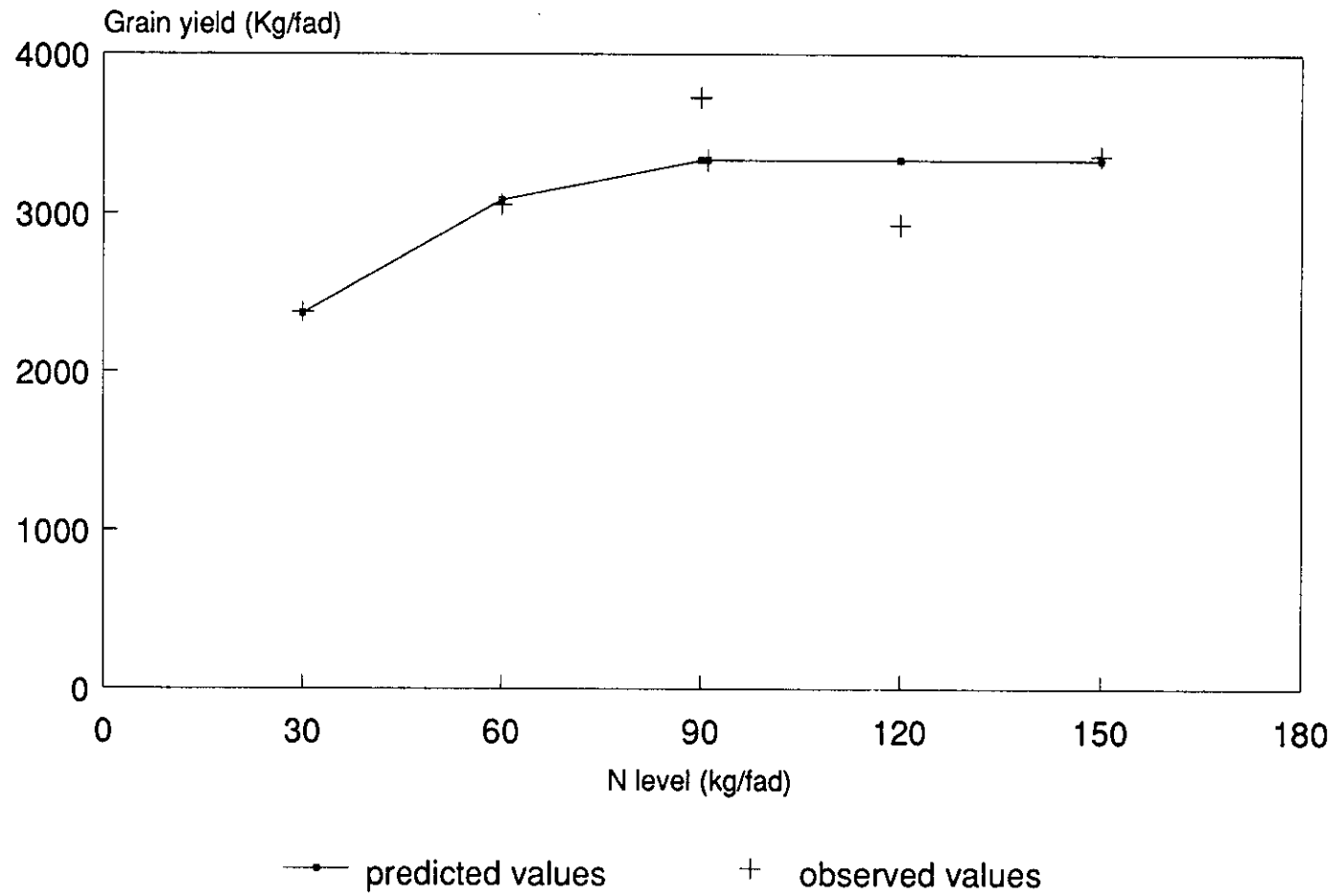
error was for the linear plus plateau model for both tested varieties, Giza 2 and T.W.C. 310. Figures 6 and 7 show that the optimum rate of nitrogen fertilization, according to the linear plus plateau model, was 110 kg N/fad. The optimum is the lowest N rate which gives the maximum response, i.e. the join point of the plateau. Similarly, the linear plus plateau model was the best model fitted to the yield data of variety Giza 2 in the July planting. Mean square error for this model was 196,826 while it was 205,798 and 197,010 for quadratic and quadratic plus plateau models, respectively (Table 35). It can be seen from Figure 8 that the optimum rate of nitrogen fertilizer was 110 kg/fad. The results of June and July plantings in the 1991 season are in line with that obtained by **Anderson and Nelson (1975).** They fitted linear plus plateau, quadratic and square root models to the yield of maize in North Carolina, U.S.A. and found that the linear plus plateau model was the best model compared with quadratic and square root models.

The estimated model for T.W.C. 310 variety planted in July 1991 is not presented, since the best fitting model is a quadratic with a positive coefficient on the quadratic term, (which corresponds to a minimum). Therefore, the nearest sensible model would be simply a plateau, at the average of all treatments (Fig. 9).

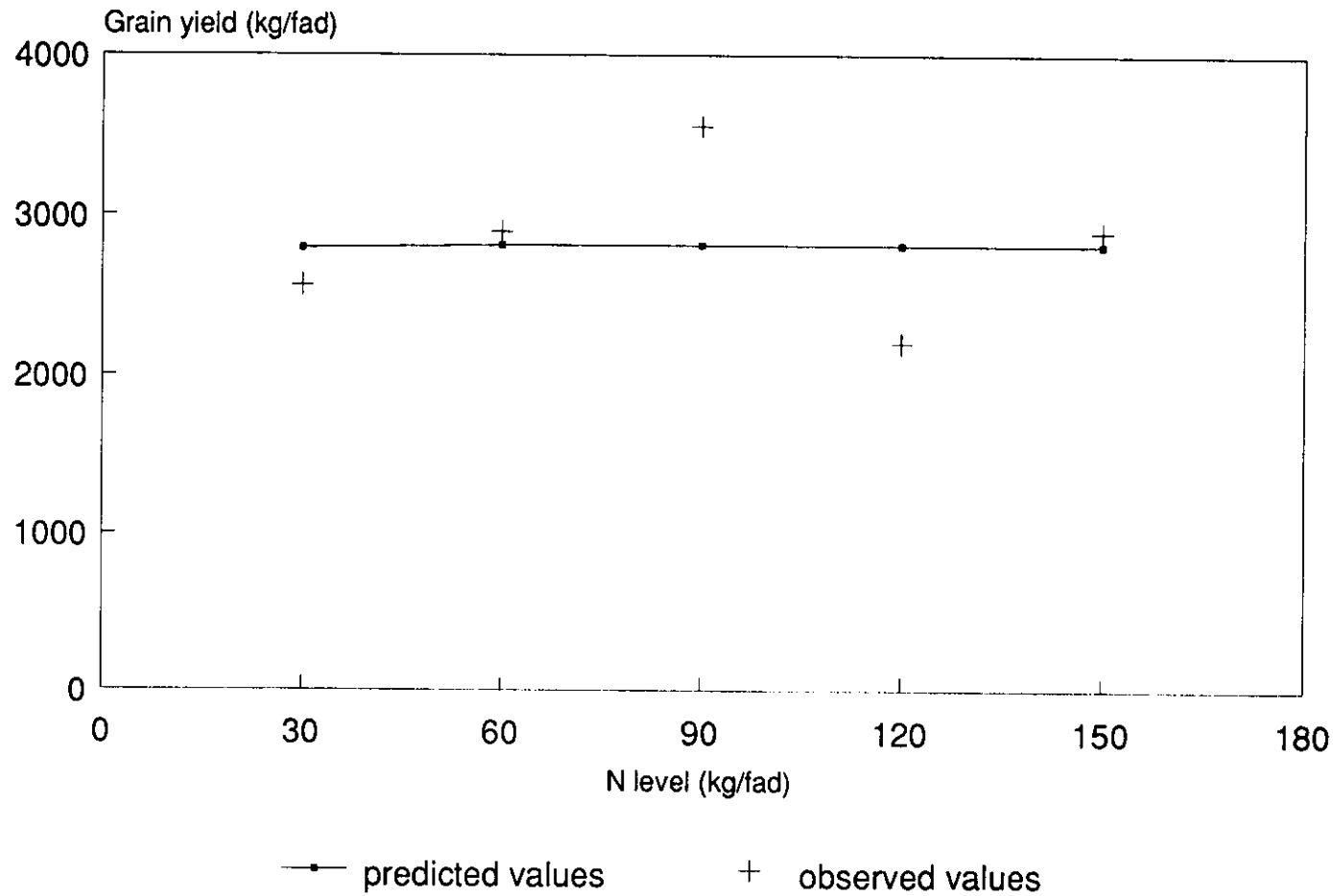
In the 1992 season, the grain yield response to N fertilization was linear plus plateau and quadratic. In the May planting, data presented in Table 35 clearly indicate that linear plus plateau model was the best model among the three models fitted to the data of grain yield for both tested varieties. The optimum rate of nitrogen fertilizer was 60 kg/fad. for both varieties (Figures 10 and 11). This result is in harmony with that obtained by **Anderson and Nelson (1975)**, who reported that the linear plus plateau model was the best model compared with quadratic and square root models.

In the June 1992 planting, the values of mean square error of T.W.C. 310 variety were 196,247, 188,600 and 189,498 for linear plus plateau, quadratic and

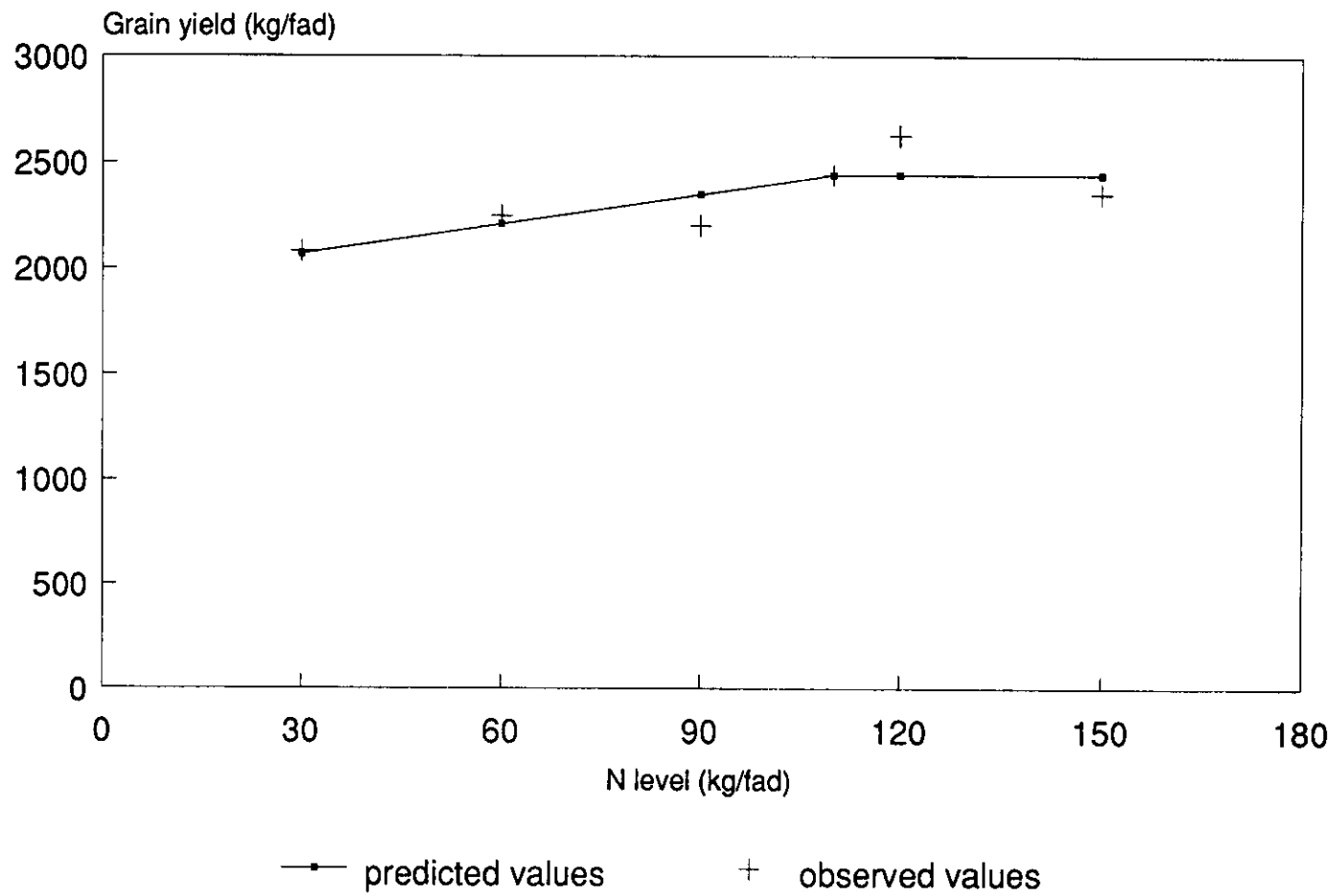
(Fig.4): Response of Giza 2 yield to N
May 1991



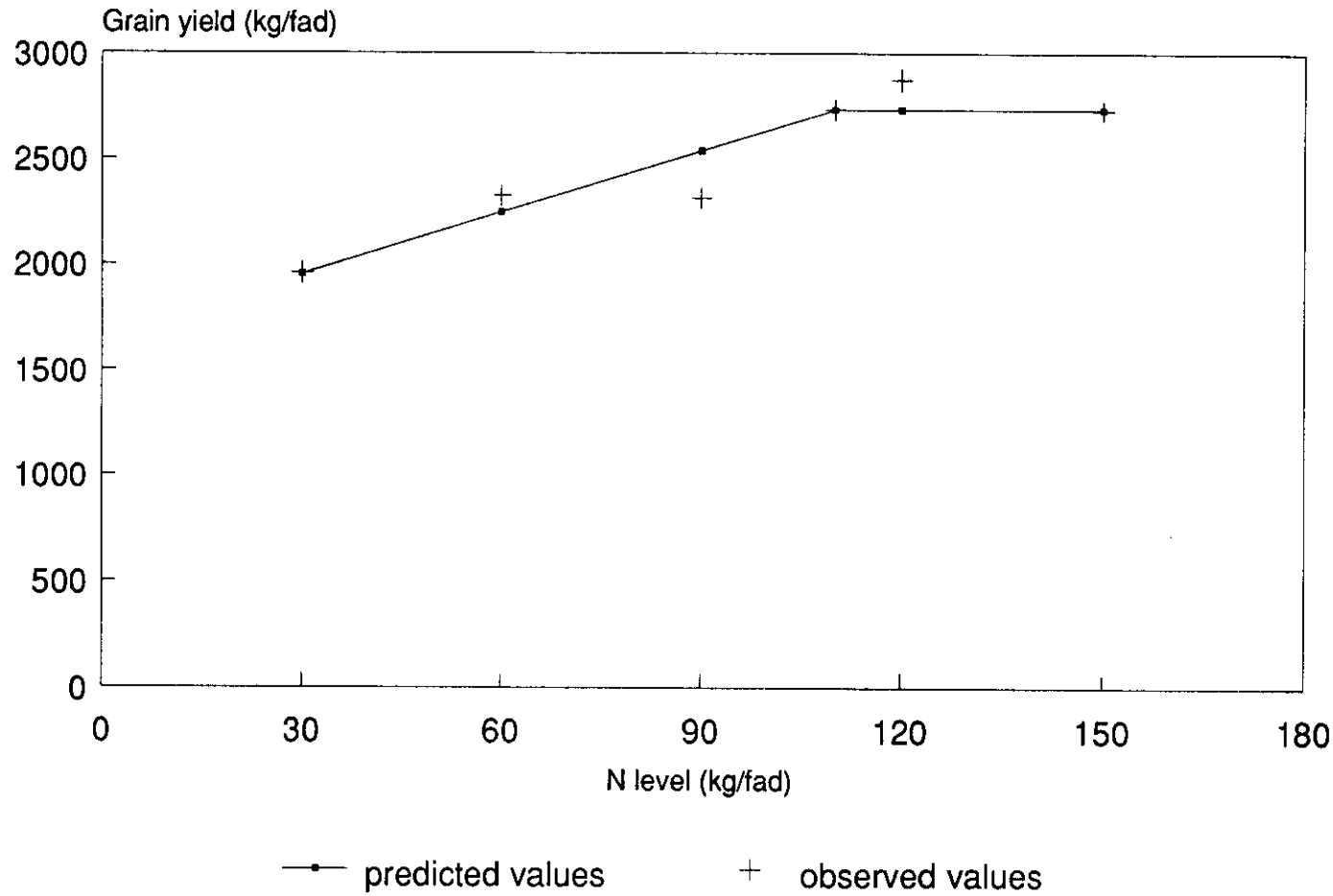
(Fig.5):Response of T.W.C 310 yield to N
May 1991



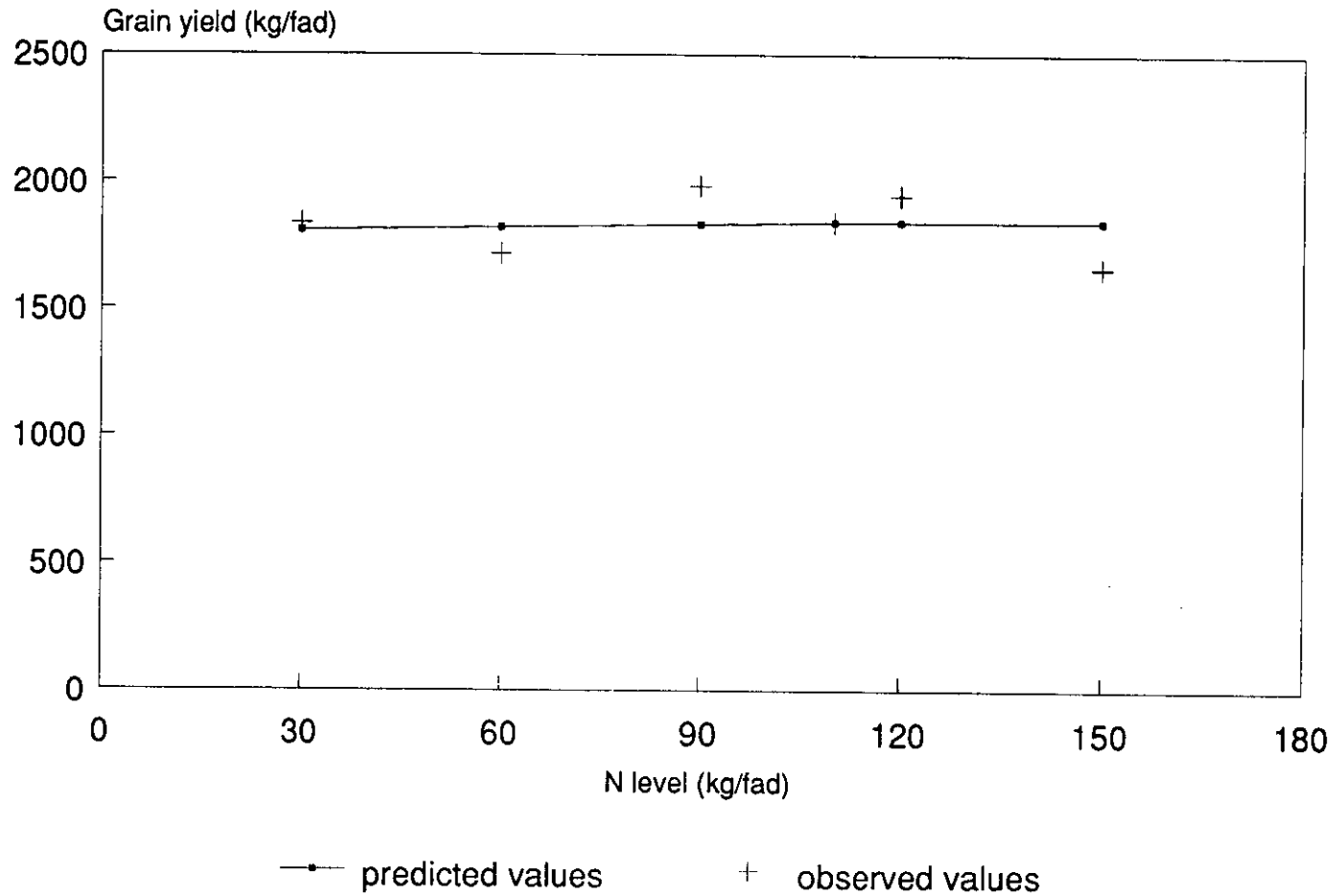
(Fig. 6): Response of Giza 2 yield to N
June 1991



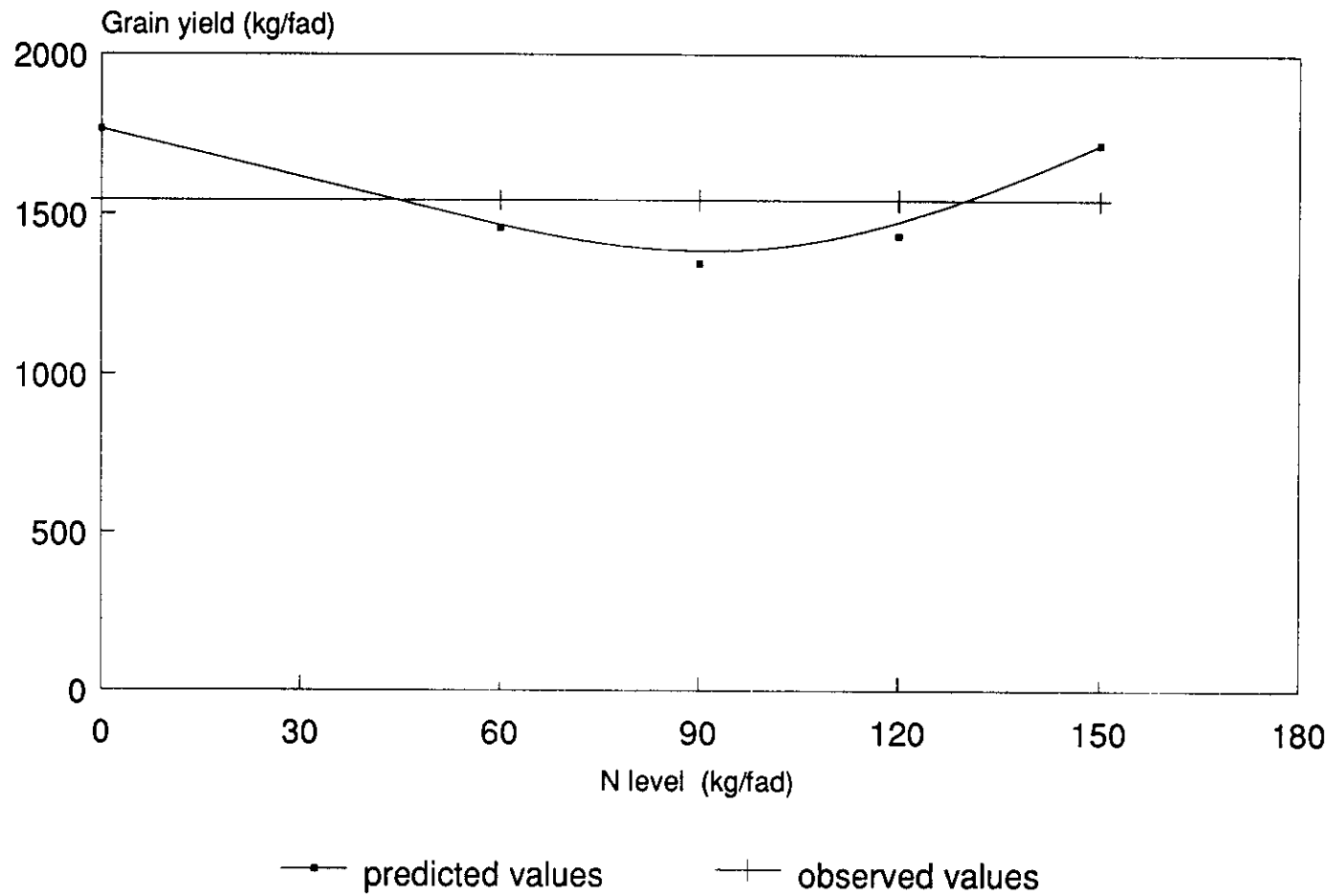
(Fig.7):Response of T.W.C 310 yield to N
June 1991



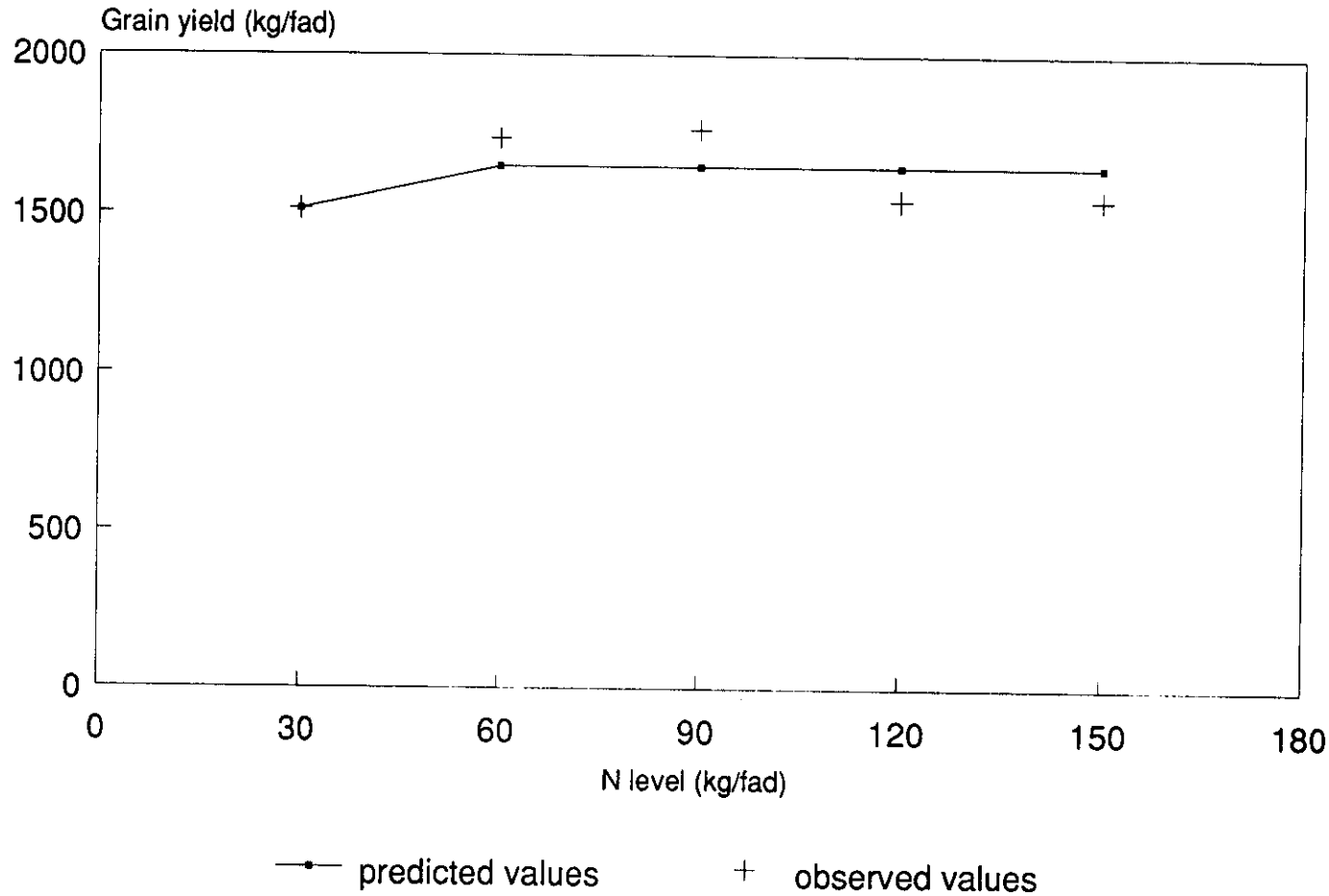
(Fig. 8): Response of Giza 2 yield to N
July 1991



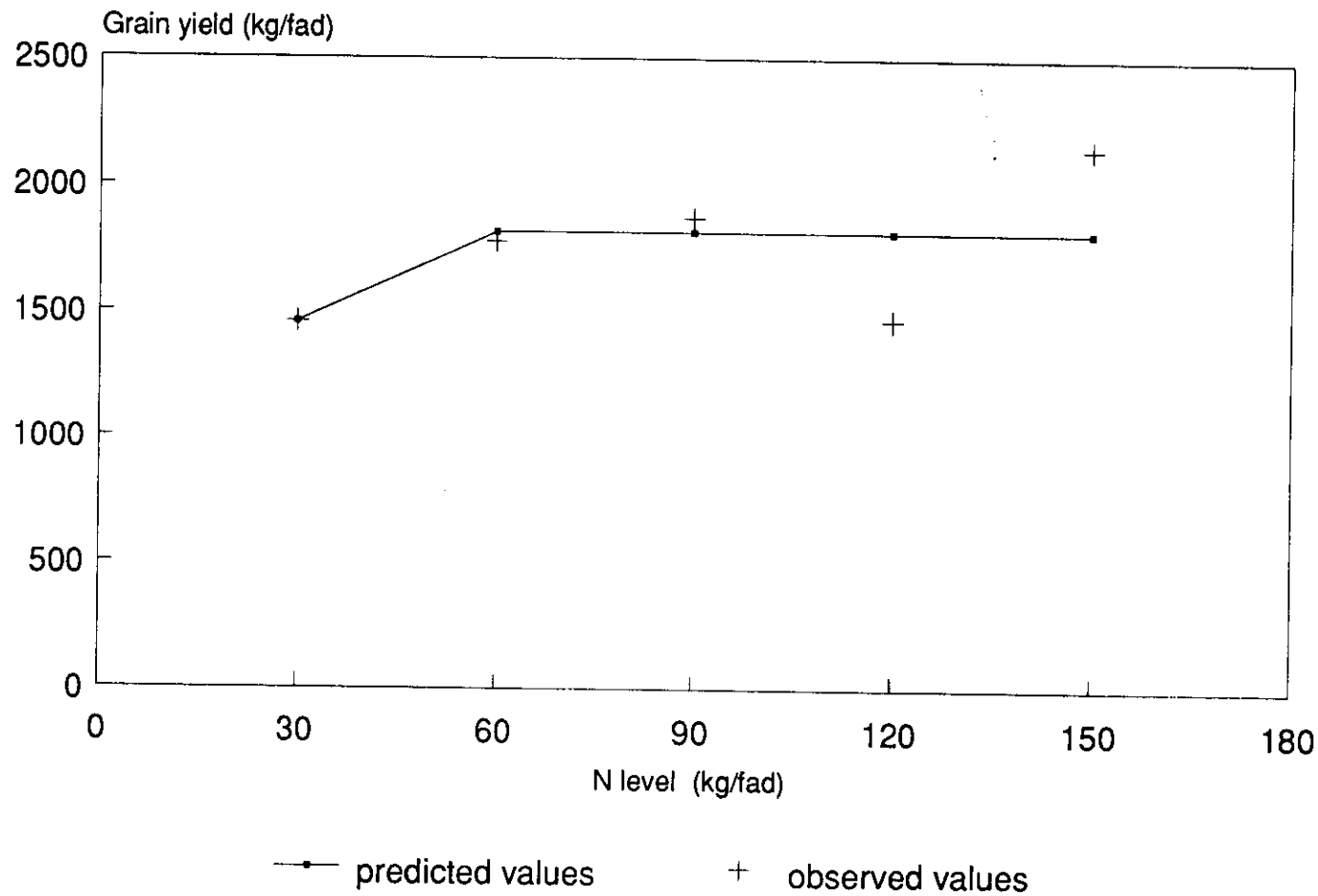
(Fig.9):Response of T.W.C 310 yield to N
July 1991



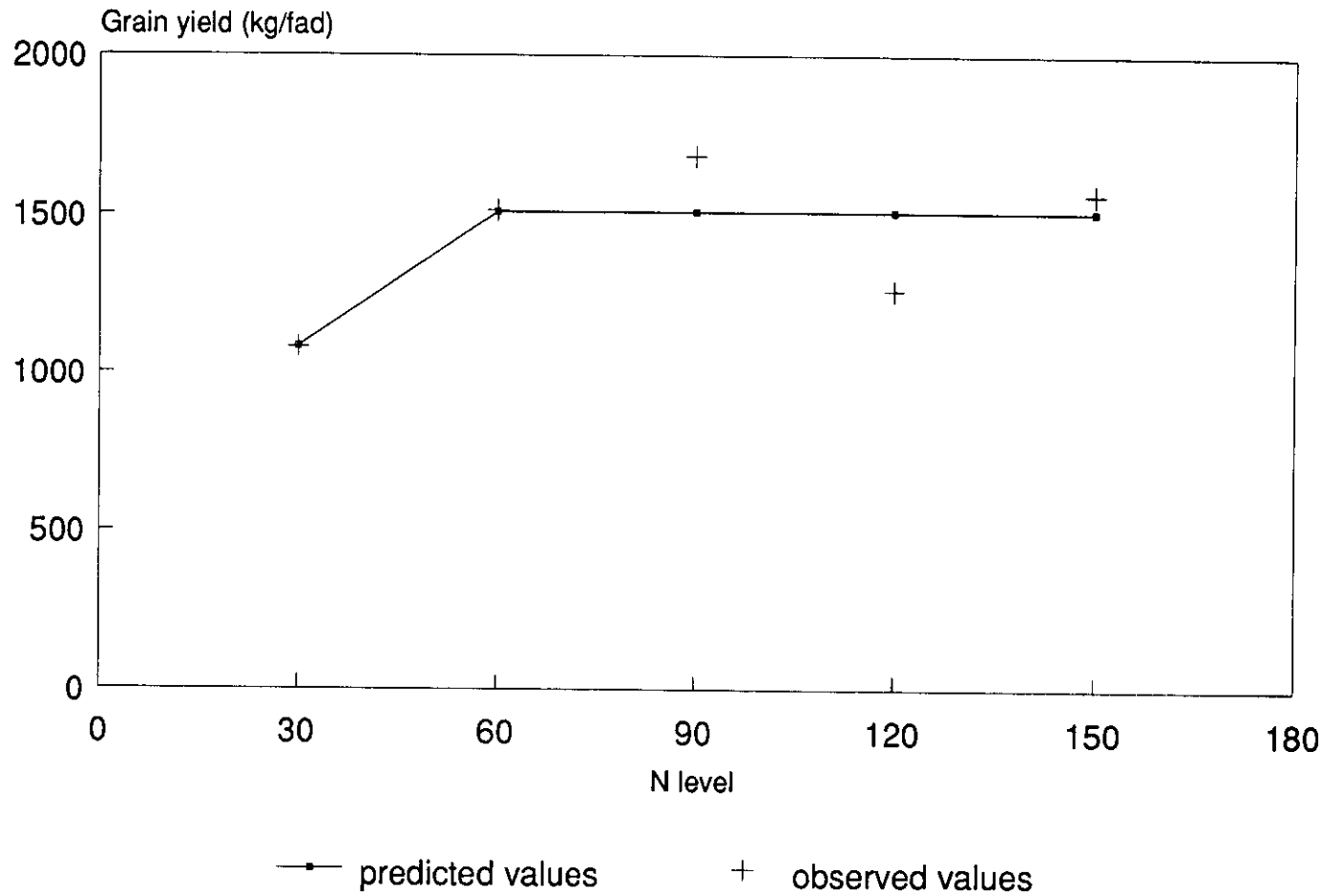
(Fig.10): Response of Giza 2 yield to N
May 1992



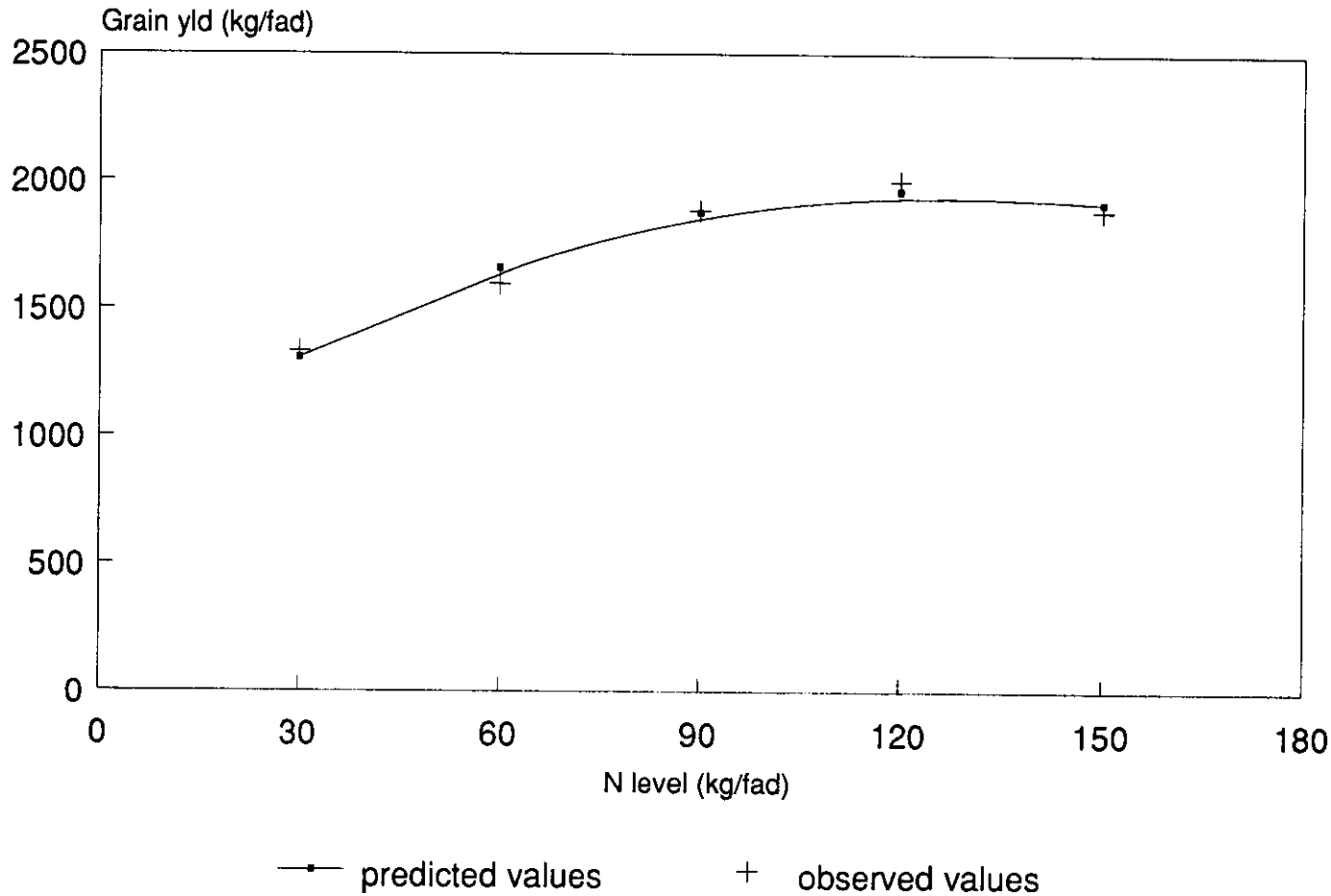
(Fig.11):Response ofT.W.C 310 yield to N
May 1992



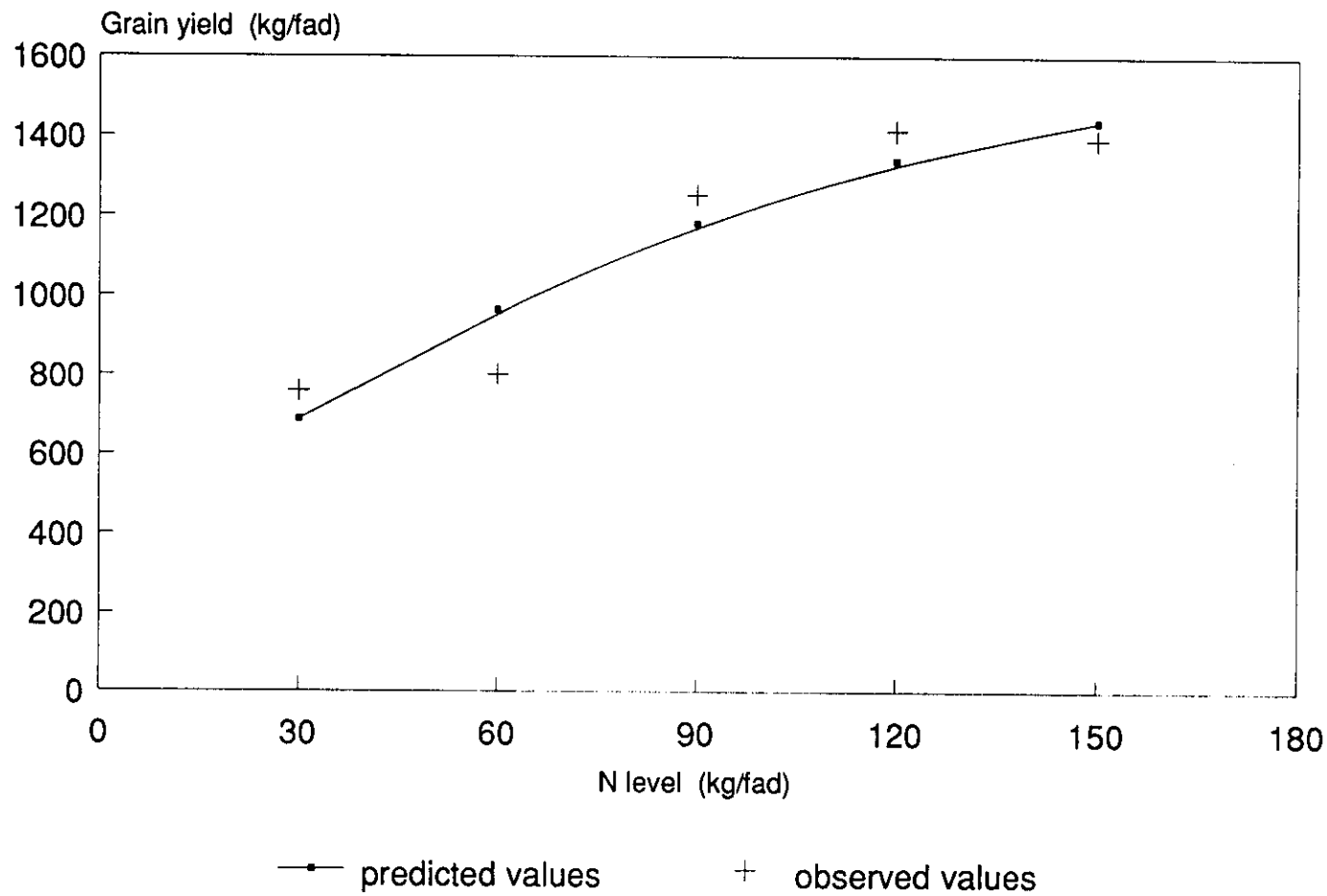
(Fig.12): Response of Giza 2 yield to N
June 1992



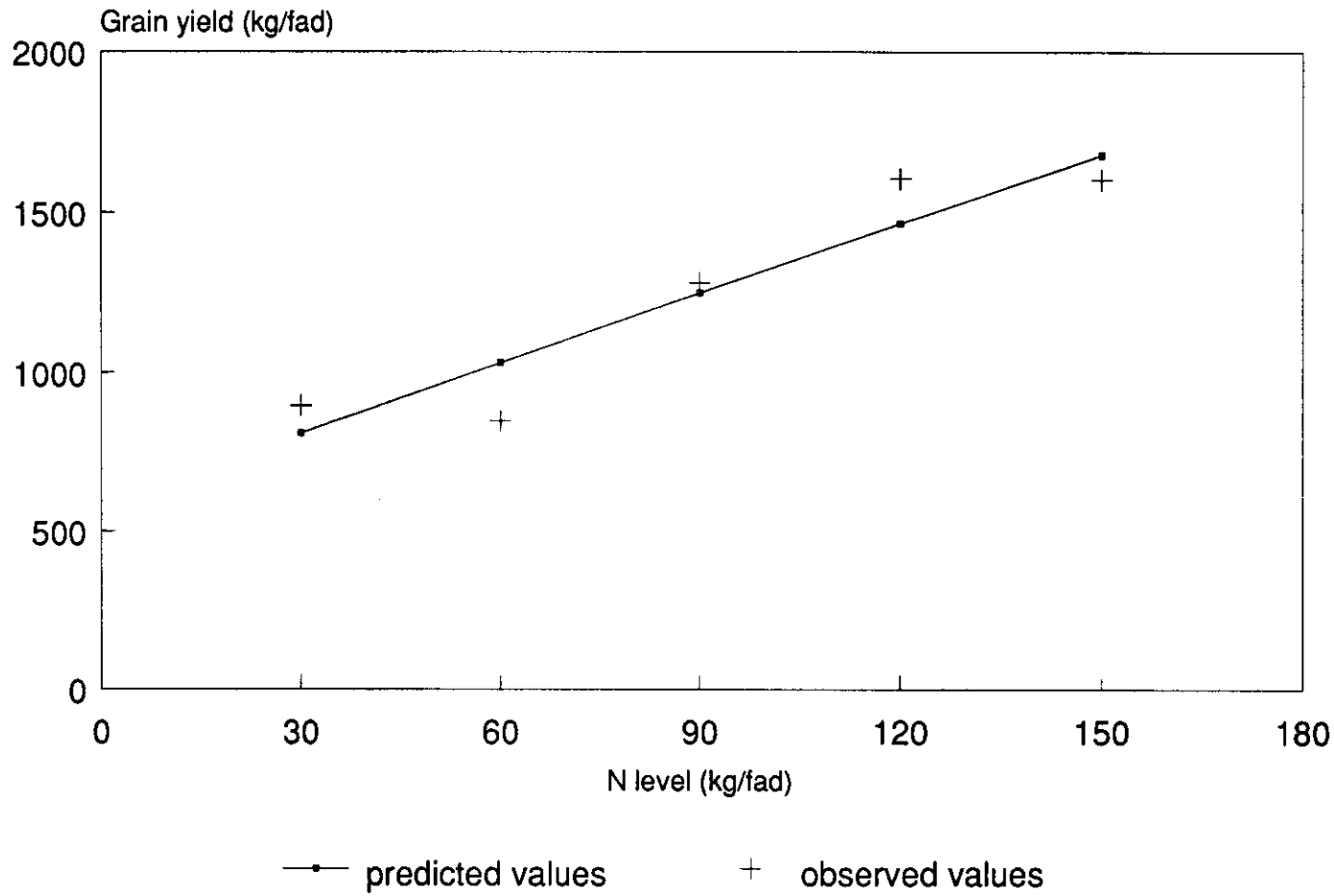
(Fig.13):Response ofT.W.C 310 yield to N
June 1992



(Fig.14):Response of Giza 2 yield to N
July 1992



(Fig.15):Response ofT.W.C 310 yield to N
July 1992



quadratic plus plateau models, respectively, (Table 35). These values indicate clearly that the quadratic model was the best model fitted to the data of grain yield of T.W.C. 310 variety since it had the least mean square error (Figure 13). The maximum rate of fertilizer nitrogen was 124 kg/fad. and it produced maximum grain yield which was 1960.61 kg/fad.

In the July 1992 planting, the best model fitted to the data of grain yield of both tested varieties, Giza 2 and T.W.C. 310, was the quadratic model. Its mean square error was less than those of the other two models, linear plus plateau and quadratic plus plateau, (Table 35 and figures 14,15).

The last two results of June and July plantings in the 1992 season, are in line with that reported by **Engelstad and Parks (1971), Awasthi and Tewari (1976), Balko and Russell (1980), Singh *et al* (1980) and Nimje and Seth (1988)** who demonstrated that the quadratic model was well fitted to the data of maize yield.

Concerning yield data of T.W.C. 310 variety planted in May 1991 season (Figure 5) and of Giza 2 variety planted in June 1992 season (Figure 12), although the quadratic plus plateau model has the minimum mean square error for these data, this model was not estimable since the join point was estimated to be less than 60 kg N/fad. (In order to fit a quadratic equation, at least three points of support are required). Thus, the linear plus plateau model was used, which is estimable with a join point less than 60.

Economic analysis:

The best fitting response functions for each of the tested varieties, Giza 2 and T.W.C. 310, planted in May, June and July during the 1991 and 1992 seasons are presented in Table (35). The regression equations are given in Table 36 and the economic analysis results of nitrogen fertilization are shown in Table (37).

In the 1991 season, the economic nitrogen fertilization rate with a nitrogen/maize price ratio of 2.27 (£E/kg : £E/kg) ranged from zero to 110 kg N/fad.

Table 37: The economic analysis of nitrogen fertilization of maize varieties planted in May, June and July during 1991 and 1992 seasons.

Planting dates	varieties	Optimum N dose (kg/fad.)	Yield at opt. N (kg/fad.)	Return (£E/fad.)
		1991		
May	Giza 2	87	3330.00	1691.73
	T.W.C 310	0	2778.00	1500.12
June	Giza 2	110	2442..00	1184.06
	T.W.C 310	110	2733..00	1341.20
July	Giza 2	0	1795.00	969.30
	T.W.C 310	-	-	-
		1992		
May	Giza 2	60	1648.00	816,49
	T.W.C 310	60	1816.00	907.21
June	Giza 2	60	1509.00	741.43
	T.W.C 310	109	1945.00	916.91
July	Giza 2	150	1437.00	592.41
	T.W.C 310	150	1680.00	723.63

The yield of grains at optimum dose of nitrogen fertilization ranged from 1,795 to 3,330 kg/fad.

In the 1992 season, the optimum nitrogen fertilizer rate ranged from 60 to 150 kg N/fad. The grain yield of maize at optimum dose of nitrogen fertilization ranged from 1437 to 1945 kg/fad.

Knapp and Reid (1981) found that the economic optimum N rate was 134 kg N/ha (56.2 kg/fad). **Fox and Piekielek (1983)** reported that the optimum N rate ranged from 84 - 91 kg/ha (35.2 - 38.2 kg/fad). Also in their study in **Fox and Piekielek (1990)**, they found that the optimum N rates were 0, 122 and 134 kg/ha (0, 51.2 and 56.2 kg/fad). **Nimje and Seth (1988)** pointed out that the economic optimum rates of N were 103.4, 106.8 and 102 kg/ha (43.4, 44.8 and 42.8 kg/fad). Also, **Cerrato and Blackmer (1990)** stated that optimum rate of N ranged from 128 to 379 kg/ha (53.7 - 159.1 kg/fad).

The optimum nitrogen rate of T.W.C. 310 variety planted in July 1992 was very high, calculated to be 1868 kg N. This is because the quadratic coefficient of the response equation was very small, consequently the inflection point of the curve is out of the range of fertilizer rates used in the present study. We, therefore arbitrarily estimate the optimum of 150 kg N, the maximum rate studied.

Although the nitrogen/maize price ratio was fixed for all dates of planting, net profit/fad. varied from the planting to another. This is because the response of the grain yield to nitrogen fertilizer differed among the planting dates and accordingly, the optimum rate of fertilizer was different. As a matter of fact, the economic techniques depend mainly on the type of model fitted to the yield data and also on the ratio of the price of fertilizer and selling price of the grains.

The fact that the estimates of profitability and yield come from response functions to nitrogen fertilization is not quite sufficient to allow for accurate comparisons between the two tested varieties. For instance, information on

interaction between nitrogen and other variables is not considered when these optima were calculated. Hence these results should be interpreted cautionly. However, at least they give some indication about relative economic performance of the two tested varieties at different planting dates. A more detailed economic analysis would be required to verify these results.

Stepwise regression analysis:

Variables explaining maize grain yield are presented in Table 38. The data in the Table indicate that 8 of the 17 variables were accepted as significantly contributing to variation in maize grain yield. The results showed that 68.75% of the total variation in the yield could be linearly related to the studied variables. 66.99% of the total yield variation could be attributed to the variables included into the model and 1.76% could be due to the eliminated variables. The highest value of R^2 was for years, first planting date and second planting date, respectively. These values of R^2 indicate the magnitude of the environmental conditions in maize production.

According to their relative importance as measured by the partial R^2, the variables included in the model could be arranged in a descending order as follows: years, first planting date, second planting date, shelling percentage, ear length, weight of 100 kernels, plant height, nitrogen fertilization and varieties.

These results are in rough agreement with that obtained by **Ashmawy (1989),** who reported that plant height, weight of 100 kernels, shelling percentage and ear length had contributed to the grain yield of some maize varieties. On the other hand, **El-Kalla and El-Rayes (1984)** found that varieties and leaf area were the most important variables contributed to the grain yield of maize.

It is seen in Table 38 that the coefficient of both first and second planting dates are less than zero indicating an intercept less than of the third planting. This suggests that the yield of third planting is higher than those of first and second

Table 38: Variables explaining maize grain yield by using stepwise multiple linear regression analysis over 1991 and 1992 seasons.

Variables	Parameters	R^2 %*	Partial R^2 %	Pr > |T|
Intercept	-6428.72			0.0001
Years*	405.87	30.74	30.74	0.0001
Planting date (1)*	-256.13	43.11	12.37	0.0872
Planting date (2)*	-122.44	50.83	7.72	0.2590
Varieties*	263.35	50.93	0.10	0.0006
Ear length	77.31	55.53	4.60	0.0001
Shelling percentage	47.72	61.25	5.72	0.0001
Weight of 100 kernels	44.04	63.65	2.40	0.0001
Nitrogen fertilization	78.77	65.25	1.60	0.0006
Plant height	5.87	66.99	1.74	0.0014

* Years were coded as 1 0 for (1991, 1992)

* Date (1) coded as 1 0 0 for (May, June, July)

* Date (2) coded as 0 1 0 for (May, June, July)

* Varieties coded as 1 0 for (Giza 2, T.W.C. 310)

* R^2 for accepted variables = 66.99%

* R^2 for eliminated variables = 1.76%

* R^2 for all studied variables = 68.75%

plantings, respectively which is not true. In order to understand this anomaly, the interaction between planting dates and each of the significant variables included in the model by stepwise procedure was studied and the results are shown in Tables 39-a and 39-b.

Results in Tables 39-a and 39-b indicate that there was a significant interaction between planting dates and each of plant height and weight of 100 kernels. Yield of each planting was calculated and plotted against the plant height and also against the weight of 100 kernels (Figures 16-a and 16-b). It is clear that the slope of the third planting is lower than those of first and second plantings, and the yield of the first and second plantings is higher than that of the third planting. The reason for this case is probably due to the correlation between the independent variables and the dependent variable, the grain yield, and/or the correlation between the independent variables themselves and this multicollinearity might affect the regression coefficient of the planting dates.

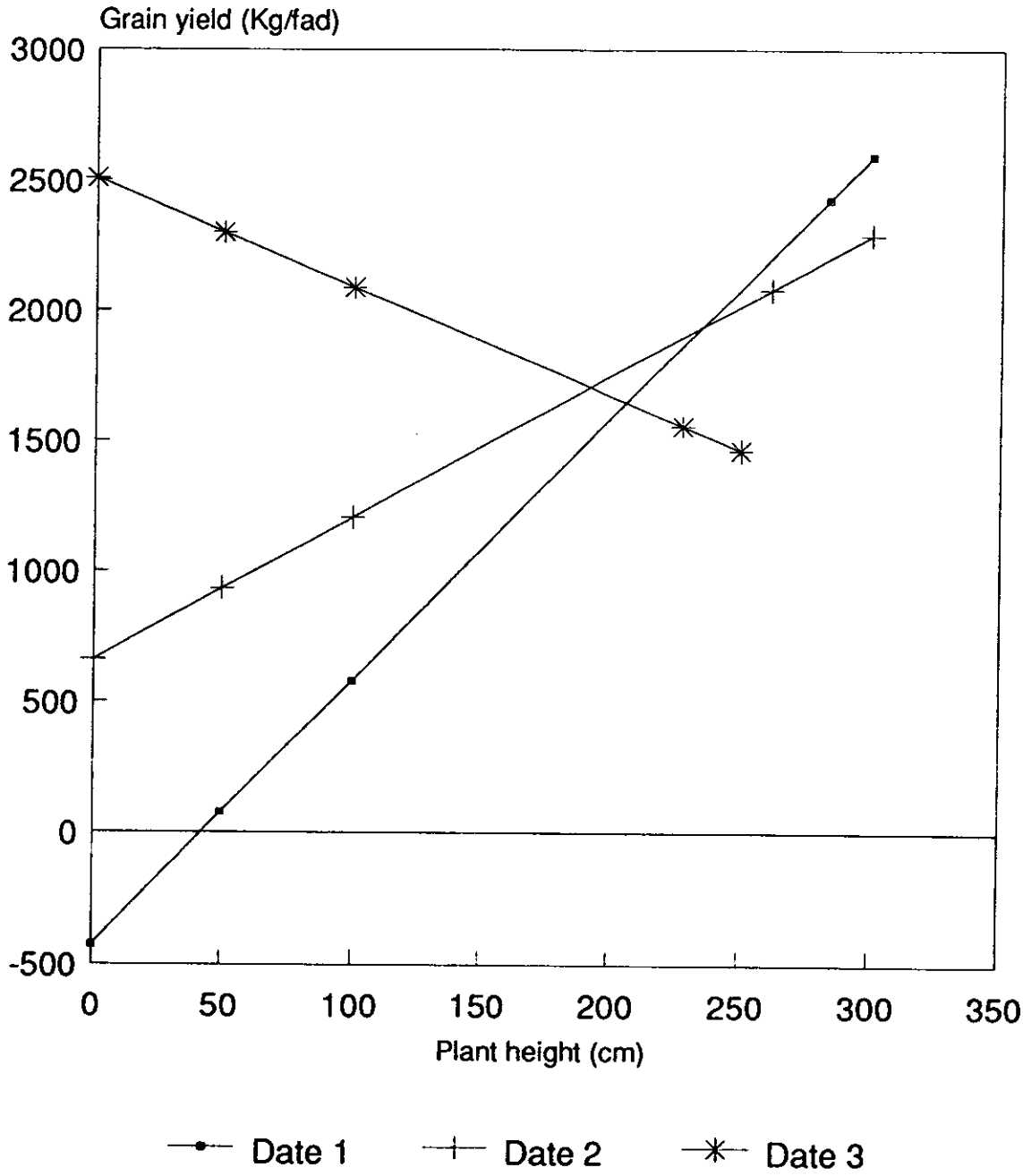
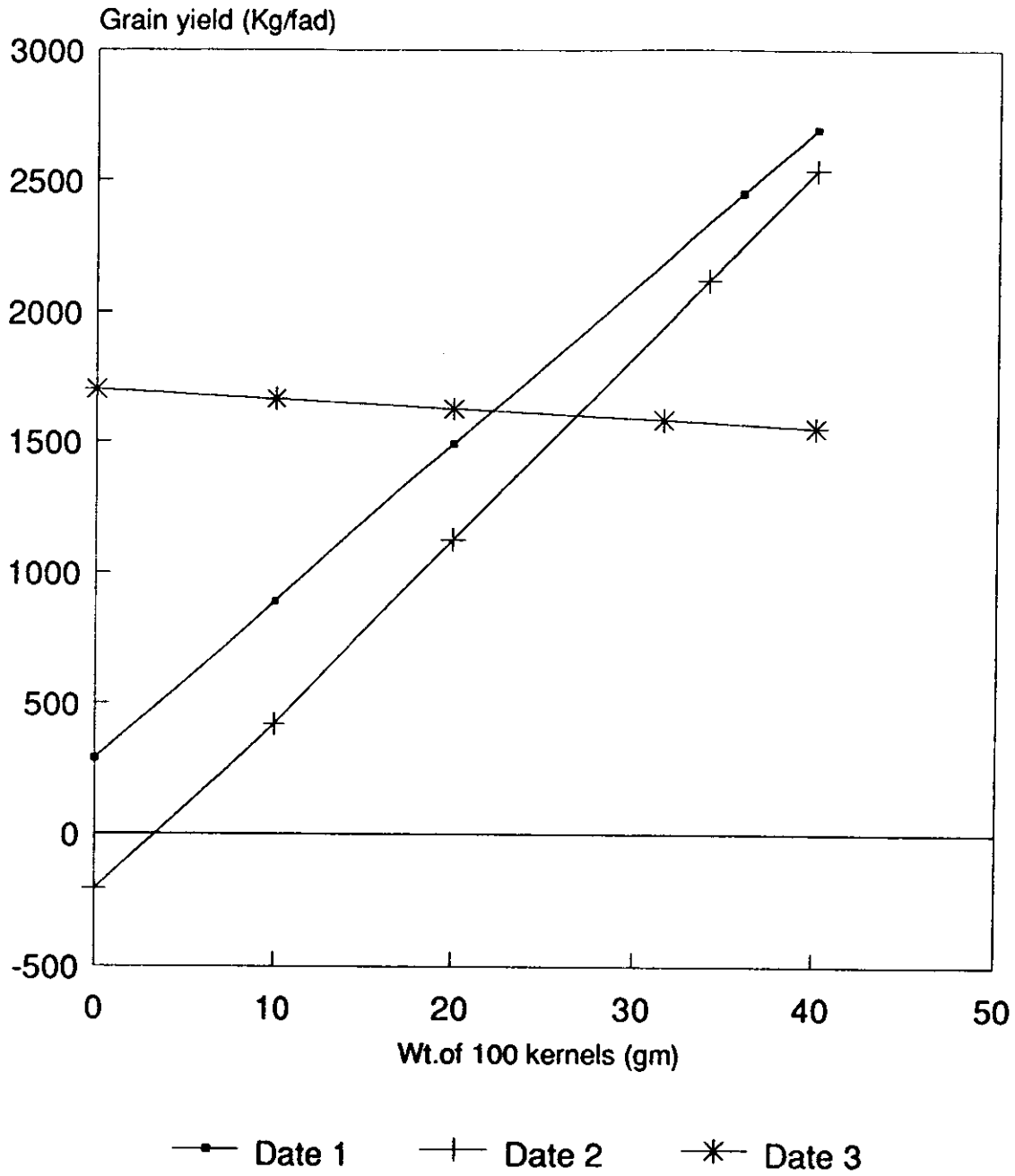
Table 39-a: Variables contributing to maize grain yield by using stepwise regression analysis over 1991 and 1992 seasons.

Variables	Parameters	Pr > |T|
Intercept	-3197.7789	0.0157
Years	395.9526	0.0001
Planting date (1)	-3630.9815	0.0004
Planting date (2)	-2250.0965	0.0310
Varieties	220.8399	0.0038
Nitrogen fertilizer	73.0261	0.0013
Ear length	72.9694	0.0001
Shelling percentage	34.9823	0.0020
Weight of 100 kernels	45.4153	0.0001
Plant height X date (1)	10.0683	0.0001
Plant height X date (2)	5.4342	0.0319
Plant height X date (3)	-4.1808	0.2640

Table 39-b: Variables contributing to maize grain yield by using stepwise regression analysis over 1991 and 1992 seasons.

Variables	Parameters	Pr > |T|
Intercept	-4481.5684	0.0001
Years	490.5358	0.0001
Planting date (1)	-2287.6387	0.0067
Planting date (2)	-2507.5645	0.0021
Varieties	280.4783	0.0002
Nitrogen fertilizer	81.0255	0.0003
Plant height	5.2290	0.0044
Ear length	84.8486	0.0001
Shelling percentage	40.8341	0.0002
Weight of 100 kernels X date (1)	60.2459	0.0013
Weight of 100 kernels X date (2)	70.7504	0.0001
Weight of 100 kernels X date (3)	-3.7952	0.8347

(Fig.16-a): Grain yield at three dates
at different heights of plant



(Fig.16-b): Grain yield in three dates
at different Wt.of 100 kernels