I. INTRODUCTION

Maize is one of the most important strategy cereal crops in Egypt. The total production of maize in 2003 season reached about 5.76 million tons resulted from an area of 1.66 million feddans (feddan=4200m^2). Most of that area is planted by high yielding hybrids. Maize productivity increased from 10.8 ard./fed^{-1} (ardab=140kg) in 1980 to 24.80 ard./fed^{-1}in 2003. This increase in productivity has been realized as a result of different factors such as release of high yielding hybrids, fertilizers and plant densities.

The increase of grain yield of maize could be achieved by the development of maize could be achieved by the development of high yielding varieties suited to different environmental conditions, better soil management and use of improved form techniques.

The growth, Yield and yield components of corn were studied by many others. In this respect **Kennedy and Tchan (1992), Gouda *et al* (1993), Tantaway (1994); Aly *et al.* (1996)** and **Soliman *et al.* (1999)** showed that raising nitrogen fertilization levels considerably increased grain yield and most of its components but the use of intensive and untraditional rates of mineral fertilizers increase the costs of agricultural production. It is well known that nitrogen plays an important role in different growth processes in maize plant but most of mineral fertilizer elements are either fixed in soil or leached to pollute the environment (Salem 2000). The considerable variation in the response of ear population density to N among seasons and sites might be the consequence of variation in the timing of N application and availability in relation to crop demand.

Maize grain yield can be increased by raising plant population **(Larson and Hanwey 1977)**. But this relationship is parabolic. At low populations, yield is limited by the number of plants, while at high population, Yield is limited by the number of barren plants intrarow spacing and competition for water as well as light and nutrients determine optimum plant densities for each grow environment **(Karten and Comp 1985)**. The aim of the present investigation was to study effect of varieties nitrogen fertilization and plant density and their interactions on growth attributes, yield and yield components as well as grain yield of maize.

II. REVIEW OF LITERATURE

The present investigation is concerned with the effect of maize cultivars, nitrogen fertilization, plant density and their interaction on some growth attributes. Yield and its components of maize. Hence, the flowing review on each of such three factors will be separately presented as follows:

2.1. Role of cultivars

Mouris *et al.*(1970), studied the performance of two double cross hybrids and one open-pollinated cultivars. They found that the open-pollinated cultivar; American Badri, exceeded the two hybrids in number of barren stalks while the two maize hybrids surpassed the open-pollinated cultivars in the yield per hectare and yield components: I,e.; number of ears per plant, grain weight/ear and the ratio of grain weight to ear weight. The difference between the two studied hybrids in grain yield/ha was obviously atributed to the difference between them in the yield components.

Genter and Camper (1973), conducted such study using six hybrids of maize representing three maturity classes, i.e., early mid season were chosen on the basis of superior grain yields for their respective maturity class in the previous trials. Their data revealed that, early hybrids when compared with the latter ones, tended to be higher regarding proportion of ears, but lower in proportion of stalks, weight per ear, plant and ear height and moisture of grain at harvest.

Pucaric (1974), found that, plant height of the early maturing maize hybrid, increased linearly, while that of the medium and late maturing ones increased in the shape of curvilinear with increasing plant density from 25 up to 75 thousand plants per/ha.

Eraky *et al.*(1980), pointed out that, maize hybrids revealed a significant superiority in each of plant height ear height, number of ears/plant, number of grains/row, 100-grain weight and grain yield/fed., over than those of open-pollinated varieties. While the reverse was detected in ear diameter, number of rows/ear and number of grains/ear.

Osman *et al.* (1980). showed that, the grain yield was significantly affected by varieties in most of the locations.

Eweis (1981).stated that, varieties were significantly different in barreness, ear number/plant, rows number/ear, kernel number/row, shelling percentage, 100-kernel weight, effect of planting dates and irrigation intervals on yield, kernel weight and grain yield.

Hussein *et al.* (1981), reported that, the open-pollinates varieties were superior in each of plant height, ear high and stem diameter. Meanwhile, maize hybrids were higher in ear length number of rows/ear, number of grains/ear, 100-grain weight, number of ears/plant, grain yield/plant and grain yield/fed. Than open-pollinated varieties.

Shalaby and Omer (1981), evaluated the productivity of six varieties of maize, which different in their maturity classes. These varieties were: a) three late-maturing varieties; A.E. “Shed.3” and “V.C.69”,b) two medium-maturing varieties; “Alex.1” and “G.H.355” and C) a very early-maturing variety, “Sab”. Their results revealed that, the two medium-maturing varieties gave the highest yield. While, the earliest maturing variety gave the lowest yield. The three late-maturing varieties exhibited a moderate productivity. The early variety “Sab” was the shortest one and had a smaller number of green leaves per plant.

Eraky *et al.* (1982), reported that, hybrids significantly surpassed those of open-pollinated varieties in number of green leaves, leaf area per plant and were earlier in pollen shedding and silking.

El-Ashmoony (1983), reported that, open pollinated varieties were significantly higher in plant height, leaf area index, ear height, stem diameter and number of days to mid-flowering than double-cross hybrids.

Khalifa *et al.* (1983), studied the response of fourteen local and exotic maize cultuvars to different nitrogen levels for two seasons. They stated that, the “variety x nitrogen level” interaction had no appreciable effect on the most studied characters; except for number of kernels per row in one season and number of days to 50% silking and ear weight in the other season. Their data also showed that, varieties having the tallest stem were characterized by a higher number of leaves above and below the ear and *Vice versa*. They added that, the relative ranking of maize varieties. Which respect to leaf area, was found to be proportionally associated with plant height and number of leaves on the stem.

Salem *et al.* (1983), stated that, the differences among open-pollinated varieties (American Badri and Shadwan) and two hybrids (D.C.19 and Poineer514) were significant for both growth characteristics yield and yield components. The grain yield of “Pioeer 514” was over yielded than those of shadwan and A. Badri by 18 and 34%, respectively.

El-Hattab *et al.* (1985), stated that, Cairo-1 cultivar surpassed each of “Giza2” and “Pioneer 514”in each of number of green leaves, leaf ear length, number of grains/ardab and gave the lowest grain yield/plant and grain yield/fed., whereas “Giza2” variety significantly produced the highest ear diameter, grain yield/plant and grain yield/fed.

Gomma (1985), found that, maize cultivar “Giza2” surpassed “pioneer 514”in plant height, percentage of barren plants and of lodged plants, stem diameter and percentage of oil in grain.Whereas, “Pioneer 541” surpassed”Giza2” in number of ears/plant and protein percentage.

El-Hefnawy and Galal (1986), concluded that, the early maturing varieties gave shorter plants with lower yielding ability compare with late-maturing varieties.

Mourad *et al.* (1986), revealed that, maize hybrids”S.C.9”and “D.C.202” gave the highest values of green leaf number as well as leaf area per plant and were earlier than open-pollinated varieties “Giza2” and “Carro-1”.

El-Agamy *et al.* (1987), found that, double cross-202 gave more number of grains/ear than “Giza2” variety which had more number of rows/ear.

Nigem (1989), reported that, significant differences were found among nine maize varieties. In general, "D.C.202",Giza2" and "Cairo-1" values were superior in grain yield, ear length number of rows/ear, number of grains/ear, number of green leaves and leaf area/plant as compared with "Local-1","Lecol-2","Sabeeny",Nab El-Gamal","pioneer514" and "Pop45".

Abdul-Galil *et al.* (1990). evaluated the growth of two maize cultivars, "Giza2" and "b.c.202" at three planting densities of 42.9, 55.9 and 84.9 thousand plants per hectare. They concluded that the superiority of the hybrid "D.C.202" over the synthetic variety "Giza2" was quite evident. The hybrid had longer photosynthesizing surface expressed in leaf area per plant and higher leaf area index than the synthetic variety. This was reflected in higher rate of growth on absolute crop growth rate (C.G.R.) and relative growth rate (R.G.R.).

El-Bialey *et al.* (1991), revealed that, there were varieties differences in growth and yield characters. Plants of both "S.C.10" and "D.C.215" were taller but had lower number of rows/ear than those of "Giza2" in ear length and number of grains/row. With respect to grain yield, "S.C.10" cv. Produced higher yield followed by "D.C.215" while "Giza2" gave the lowest yield.

Bedeer *et al*. (1992), found that, maize hybrids "D.C.204 and 215" produced higher grain yield than the open-pollinated variety "Giza2"D.C.204" was the most productive hybrid (25.17ard/fed) followed by "D.C.215" and "Giza2"(24:37 and 23.5ard/fed) respectively.

Gouda *et al.* (1992), indicated that, varieties differed significantly in studied characters. In general, varieties could be arranged in descending order according to grain yield as follow;"S.C.10"; "T.W.C.310";"D.C.204";"Giza2";"D.C.pioneer";"Taba" and "Pop45y".

Salem (1993), found that, "Giza2" variety had superiority than population 45 in respect to the most studied characters, i. e., number of leaves/plant, fresh weight/plant, dry weight/plant and leaf area index, except, the stem diameter in the first growing season.

Younis *et al.* (1994), indicated that, cv."S.C.10"had the heights values of plant height, number of ears/100 plant, grain yield (G)/plant and grain yield (ard.)/fed. While, "S.C.1`03"and "S.C.120"cvs. gave low values of grain yield about 2.5 ardab than "S.C.10"variety.

Atta-Allah (1996), found that, single cross"10"and "T.W.C.310" had the highest values for plant height, ear length stem diameter, ear leaf number of ears/plant, number of rows/ear, 100-kernel weight and grain yield/fed., while, "Giza2" gave the lowest values for the most studied traits.

Nawar (2004).found that Giza10 was superior to Giza310 and Giza2 for ear leaf area, number of grains/ears, grain weight/ear and grain yield/fed during the two seasons.

2.2. Role of nitrogen fertilization

Nitrogen fertilization is among the most important cultural practices which control maize production. Many agronomists believe that, increasing average grain yields of maize could be achieved particularly by increasing the nitrogen fertilizers applied per unit area.

Moursi *et al.* (1970).showed that, increasing nitrogen level up to 139.5kg N/ha, caused a gradual increase in yields of both ears and grains per hectare at harvest. The addition of nitrogen fertilizer at a rate of 139.5 kg N/ha increased the yield of grains over the control cd to 1.86 ton/ha.

Kemper (1972), stated that increasing nitrogen level under maize plants from nil up to 538kg N/ha; cause such increase in number of days to silking but increased both ear length and width.

Sasidhar and Sadanadan (1972), found that, increasing nitrogen rate from nil up to 120kg N/ha; significantly increased number of ears per plant, but did not significantly increase grain yield.

Gagro (1974).found that, increasing nitrogen level from nil to 200kg N/ha; resulted in an increase of maize plant height but under favorable moisture condition.

Ainer (1976), showed that, adding nitrogen fertilizers up to 90kg N/fed. increased the grain yield/fed., grain weight/ear, number of grain/ear as well as 100-grain weight.

Rathore *et al.* (1976). reported that, nitrogen application had positive significant effect on maize plant height and number of grain per ear.

Lashin and Ali (1977), indicated that, increasing nitrogen rate up to 90 kg N/fed., increased grain yield and number of ears/plant number of grains/ear and 100-grain weight.

Shalaby and Makhail (1979). showed that, increasing nitrogen level from 72 up to 216kg N/ha; significantly increased both plant height and area of the sixth leaf blade on plant. On the other hand opposite trend was obtained with the mean number of days to 50% of silking. Data published by the same author; **Shalaby and Makhail (1979b)** revealed that, some yield components namely; percentage of two-eared maize plants, uppermost ear length, number of kernels per row and seed index, significantly increased as nitrogen level was increased from 72 up to 216 kg N/ha.

Kapur and Rana (1980).concluded that, the application of 120 kg N/ha; seemed to be an appropriate dose of fertilizer for better growth of maize hybrid.

El-Kassaby and El-kalla (1981), reported that, grain yield/fed., grain yield/ear, ear length and diameter, number of grains/row, 100-grain weight and plant height of maize were gradually increased as the rate of N increased up to 120 kg/fed.

Shafskak *et al.* (1981), indicated that, increasing nitrogen level from nil up to 190.5 kg/ha; significantly increased both grain yield and crude protein per unit of land. They, also, showed that, the increase in plant height, leaf area of the upper most ear and in ear length due to the increase in nitrogen fertilization was caused with further application above 142.9 kg N/ha for the first two characteristics and above 95.2kg N/ha for the later. An opposite trend was noticed with the percentage of barren stalks. However, that effect was not significant with nitrogen levels above 47.6 kg N/ha. On the other hand, nitrogen application did not show any significant effect on both number of rows per ear and ear diameter.

Shalaby and Omer (1981), noticed that, grain yield, number of ears per plant, ear weight, plant height and number of green leaves at 75% of silking were increased with increasing nitrogen level, while, number of barren plants per hectare showed a reverse trend.

Salem *et al.* (1982), found that, increasing nitrogen level up to 144 kg N/ha in most cases, or to 72 kg/ha in some cases, significantly increased grain yield both per plant or per hectare, ear weight, ear length and diameter and number of ears per plant. Increasing nitrogen level above 72 or 144 kg/ha did not cause any significant increase in such characters. An opposite trend was obtained with percentage of barren plants.

Ashoub *et al.*(1983), reported that increasing nitrogen (form0, up to 142.9kg N/ha.) caused a significant increase in plant height at 60 days after planting, leaf area and dry weight at 45 and 60 days after planting. While ears weight/ha., grain yield/ha, and ear length showed an adverse trend.

Khalifa *et al.*(1983).reported that, nitrogen level of 107 kg/ha caused a significant increase in maize plant height, ear height number of leaves below the main ear and leaf area. Meanwhile the same level caused a significant reduction in the percentage of barren plants. Increasing nitrogen level above 107 kg/ha, did not cause any significant changes in the above mentioned characteristics. In addition, increasing nitrogen fertilizers up to 214 kg/ha, significantly increased grain yield, ear length number of kernels per row, ear weight, kernels weight per ear and 100-kernel weight per ear and 1000-kernels weight. Moreover, that level significantly reduced the number of days to 50% silking.

Moursi *et al.* (1983), stated that increasing nitrogen levels (from 72 to 180 kg N/ha.) significantly increased leaf area index (LAI), stalk diameter, ear weight, grain yield/ha and decreased percentage of barren stalks.

Tantawy (1983), indicated that applying nitrogen fertilizer at rate of (0,71.4, 142.9 and 214.3 kg N/ha.) caused significant increases in grain protein and straw yield/ha. The same trend was in only one season with plant height and other yield components, namely, ear height, ear length, number of grains/row, ear weight and weight of grains/ear**.**

Anderson *et al.* (1984), stated that, increasing nitrogen rate (224kg N/ha) caused a marked increase in the percentage of plants with synchronous silks, number of ears per plant and subsequently grain yield per plant.

Asghari and Hanson (1984), stated that, maize preceded by small grain gave an average increase of 1.88 ton/ha in grain yield obtained with the initial dose of 45kg N/ha compared with control. Further application of nitrogen above 45kg/ha showed a slight increase in grain yield.

Yagondin (1984), showed that the highest yield corn was obtained when treated with organic matter compared with inorganic nitrogen.

El-Agroudy (1985), found that increasing nitrogen rates from (87-to 262 kg N/fed), significantly increased the average of ear length, number of kernels/row, 100-kernel weight, ear weight, grain yield/plant and grain yield/fed. Where as shelling percentage decreased during the first season only. On the other, hand nitrogen rates had no significant effect on number of rows/ear during the two seasons.

Gomaa (1985), indicated that increasing nitrogen levels up to 285.7 kg/ha., significantly increased plant height lodged plant percentage, number of ears/plants, straw yield/ha, grain yield/ha, shelling and protein percentage.

Mamdouh (1985), studied effect of three nitrogen levels (60,90 and 120kg N/fed.), on growth yield and components of three maize cultivars. He obtained the highest plant height and crop growth rate at a rate of 120kg N/fed., while application of 90kg N/fed., tended to give the largest leaf area/plant, highest dry matter accumulation/plant and leaf area index. On other hand, effect of nitrogen rates on relative growth rate “RGR” was significant at the second period (50-65days) in the first period and first (35-50days) in the second season. With regard to **Islam and Abedin (1986)**, found that nitrogen application up to 120kg N/ha., significantly increased the grain yield of maize at North-West region of Bangladesh.

Ashoub *et al.* (1986), found that, increasing nitrogen rate up to 142.9 kg/ha caused such significant increase in plant height at 60 days after planting, leaf area, dry weights at 45 and 60 days from planting, ear weight percentage, grain yield percentage, seed index and ear length.

Ologunde and Ogunlela (1986), studied the response of maize to five rates of N (0,50,100,150,and 200kg N/ha.), and three plant population densities (24,48 and 72 thousand plant/ha). They found the maximum grain yield was obtained with 120kg N/ha., and population density of 50,000 plant/ha. There was a significant nitrogen plant density interaction at both locations.

Wang *et al.* (1986), planted two maize cultivars under four nitrogen levels ranged from 75 up to 300kg N/ha. Increasing nitrogen level postponed silking date for one variety.

Metwally *et al.* (1988), using (60,90 or 120kg N/fed.), with maize, they found that the highest leaf area/plant, leaf area index (LAI), dry weight/plant, number of ears/plant, grain weight/ear, grains weight/plant, grain yield ardab/fed and percentage of protein content in corn grains (9.42) were obtained with the highest rate of nitrogen fertilizer.

EI-Noemani *et al.* (1990), reported that increasilevel from (90 to 120kg N/fed), did not lead to any significant important in the performance of both leaf area and number of leaves/plant. Adding nitrogen fertilizer to maize plants did not cause any significant increases in specific leaf weight.

Younis *et al.* (1990), mentioned that increasing nitrogen rate (from 90-to120 kg N/fed.), increased grain yield and ear height. On the other hand, application of nitrogen did not affect on plant height, leaf area index (LAI), ear length and number of rows/ear, number of grains/row and number of grains/ear.

Bedeer *et al.* (1992), indicated that increasing nitrogen rate (from 105 to 120kg N/fed.), significantly increased grain yield by 3.38 ardab/fed.

Coelho *et al.* (1992), showed that, nitrogen fertilization gave a large increase in grain yields, with 120kgN/ha., increasing yield by 80% than control yields, 90% of the maximum yield was obtained with 80kg N/ha., than the N taken up by the crop, 80% was found in the grain and 20% in the vegetative material. Average percentage in dry matter (DM) ranged form 0.67 without N to 1.60 with (120-240 kg N/ha.), corresponding to the maximum grain yield.

Gouda *et al.* (1992), found that nitrogen application up to 150 kg N/fed., caused a significant increase in number of green leaves, leaf area plant ear height ear length and diameter, number of grains/row, number of grains/ear, 100-kernels weight and grain yield/fed.

Gaafar (1993), studied effect of interaction among nitrogen levels, (192, 264, 336, 408, 480 and 552 kg N/ha.), and plant density (48,72 and 96 thousand plants/ha.), on some agronomic, yield, yield components characteristics, and grain quality. He found that increasing nitrogen levels from (192 up to 336 kg N/ha.), caused a significant increase in plant height, total plant leaf area, the yield of grains ton/ha, number of ears/plant 100-kernels weight, ear length ear diameter.

Salem (1993) found that, increasing nitrogen rate from 40 to 120 kg/fed brought about such increased in stem diameter, number of leaves/plant, leaves and stem fresh and dry weight, leaf area index, grain number/row, ear weight, grain weight/ear, 100-grain weight as well as ear yield/fed.

Salwa (1993), worked on maize cultivar double hybrid 215 at five nitrogen levels (60,75,90,105 and 120kg N/fed.),concluded that plant height, ear height, yield components characters, ear yield and grain yield/fed were significantly increased by increasing N level up to 120 kg N/fed.

Abd El-Samie (1994), indicated that increasing nitrogen level from (30-up to 120kg N/fed.), increased maize plant height, ear characters, 100-kernels weight biological yield/fed and grain weight. The increase in grain yield was 24.65% in the first and second seasons, respectively, for 120kg over 30 kg N/fed.

Esmail and El-Sheikh (1994), found that nitrogen application up to 150kg/fed caused significant increases in plant height, ear height, and ear diameter over those received (60,90 and 120kg N/fed).Meanwhile, maize plots received 120 or 150kg N/fed., expressed a significant increase in 100-kernels weight and grain yield/fed.

Shafshak *et al.* (1994), studied the response of four maize varieties, to four nitrogen levels (0,80,105 and 130kg N/fed). Their results indicated that the increase in nitrogen levels significantly increased plant height number of ears/plant, ear length, ear diameter, ear weight of 100-kernels, shelling percentage and grain yield. The highest N level (130 kg N/fed.), increased grain yield over the check treatment by 36.7 and 48.9% in the first and second seasons, respectively.

Younis *et al.* (1994), reported that, increasing nitrogen level up to 135kg N/fed to delaying number of days to 50% silking, increasing plant and ear height, number of kernels/ear, number of ears/100 plant, grain yield (gr)/plant and grain yield (ard) fed.

Hassan (1995), reported that nitrogen utilization up to 100kg N/fed., significantly caused increases in number of leaves above and below the 1st ear, total number of leaves/plant, height, total leaves area/plant, leaf area index (LAI) number of ears/plant and fresh weight/plant.

Ibrahim and Ali (1995), showed that the highest grain yield/fed., grain yield/plant, number of ears/plants, ear length, number of kernels/row, weight of 100-kernels weight and leaf area index were obtained by spring of urea at 6% concentration as foliar sprays compared with the control. While there were no significant differences between (3% and 6%) concentrations for these traits.

Samia *et al.* (1995), studied the response of maize cultivar single cross 10 to nitrogen (N), phosphorus (P) and potassium. The treatments were, five N fertilizer rates, (0, 45, 90,135 and 180 kg N/fed)., two P treatments, (0 and 30 kg P_2O_5/fed.), and two K treatments, (0 and 24 kg K_2O/fed.), It was abvious that application of N fertilizer increased plant height, leaf area, number of area/plant and grain yield. Grain yield/fed significantly increased as N rates increased up to (135 and 180 and 135 kg N/fed.), in (1992,1993) seasons and the combined analysis, respectively. On the hand, they stated that the response of grain yield to N fertilizer was quadratic in both seasons.

Selim and El-Sergany (1995), stated that increasing nitrogen fertilizer levels from, (75 up 125 kg N/fed.), led to increases in number of grain/row, 100-grain weight, grain protein, number of rows/ear and grain yield/fed.

Uhart and Anrdrate (1995), attributed the increase in maize grain yield to the increases in number of grains/ear and single grain weight, as influenced by increasing N/level.

Aly *et al.* (1996) found that, nitrogen fertilizer levels of 90, 105 and 120 kg/fed were not affected any measurable on growth characters, yield and its components.

Ashoub *et al.* (1996), indicated that increasing nitrogen fertilization level from (80 to 120 kg N/fed.), caused a significant increase in ear length ear diameter, number of grains/row, weight of 100-kernels, shelling percentage, number of ears/plant, grain yield/fed.

El-Kady *et al.* (1996), found that adding nitrogen fertilizer increased significantly ear leaf ear characters, shelling percentage, 100-kernels weight, grain yield/plant and grain yield/fed. However, plant height, was not significantly affected by nitrogen fertilization.

Faisal *et al.* (1996), reported that increasing nitrogen rates increased grain yield and its attributes.

Said *et al.* (1996), showed that each increase in level of nitrogen up to (120 kg N/fed.), resulted in a significant increase in stalk diameter, ear leaf area, ear length, ear diameter, 100-kernels weight, grain yield/plant and grain yield/fed. In the same trend, grain protein content markedly increased with raising nitrogen levels.

Arshed (1997), indicated the highest plant height, grain yield/fed., number of ears/plant, ear weight, 100-kernels weight, ear length and ear diameter, number of rows/ear, number of kernels/row and shelling percentage when nitrogen levels reached 160 kg N/fed.

Ghali (1997), showed that, corn production exhibited better growth when grown on sandy loam soil than when grown on sandy clay loam one.

Hassanein *et al.* (1997), Obtained that, increasing nitrogen level up to (100kg N/fed.), led to an increase in all characters except protein percentage in the first season as well as plant height and number of rows/ear in the second season. Stalk diameter ear diameter, number of kernels/row, weight of ears/plant, grain yield/*plant and grain yield/fed., were significantly increased in both season except ear diameter was significantly increased by increasing N level fertilization up to 75 N kg/fed. In the second season, ear length was significantly increased by N level fertilization up to 125 kg N/fed. In both seasons (except ear length was significantly increased by increasing N level up to 100kg N/fed., in first season. Moreover, minimizing water use throught deficit irrigation during late season growth stage, reduced the yield. Such reduction was less than that obtained when deficit irrigation was practiced during the critical period which is mid-season growth stage.

Atta-Allah (1998), showed that, increasing mineral nitrogen fertilization increased grain yield and its attributes.

El-Zeir *et al.* (1998), studied the influence of row spacing and nitrogen fertilization of three nitrogen levels (60,100 and 140kg N/fed.), on two promising hybrids, They found that increasing nitrogen rate up to 140kg N/fed., increased plant height, weight of 100-kernels, number of rows/ear, number of kernels/row, ear diameter, ear length, grain yield/plant and grain yield ard/fed.

Mosalem (1998), stated that there were increases in leaf area/plant, leaf area index (LAI) and dry matter accumulation/plant with increasing nitrogen level from (95 to 140kg N/fed.) In addition, plant height at harvest, most ear attributes (except number of row/ear in both seasons and ear length in the first season) and grain yield/fed were significantly increased as nleincreased up to (140 between 125 and 140 kg N/fed.), in most cases.

Salem (1999), worked on maize cultivar Th.W.C310 grown at (60,90 and 120kg N/fed.) He round that plant height and stalk diameter were gradually increased as the rate nitrogen increased from 60 to 120 kg N/fed. Application of (90-and 120kg N/fed.) increased the average of plant height compared with 60kg N/fed., by 6.06% and 9.03% in first season and 2.94% and 5.18% in the second season, stalk diameter by 9.47% and 11.06% in the first season and by 13.19% and 28.02% in the second season. However, the application of 90 and 120 kg N/fed increased grain weight by 12.36% and 19.55% in the first season, by 9.22% and 13.43% in the second season and grain yield/plant by 24.63% and 38.43% in the first season and by 12.81% and 23.90% in the second season, respectively than applying 60kg N/fed.

Soliman *et al.* (1999), studied effect of three nitrogen fertilizer levels (90,120 and 150kg N/fed).On three cultivars under three plant densities (17,24 and 30 thousand plants/fed). Their results clarified that, ear length, ear diameter, grain yield/plant significantly increased with additional increment of nitrogen from (90 to 150kg N/fed), in both growing seasons. The highest grain yield/plant were (190.9 and 195.1gm) obtained from 17000 plants/fed., and application of 150 Nkg/fed. While, the lowest values were 103.2 and 101.6gm obtained from 30000 plants/fed and 90 kg N/fed., in 1996 and 1997 season, respectively.

Badran (2000), found that increasing mineral nitrogen fertilization (from 0.0 to 120kg N/fed.), increased all the studied characters, except the number of surviving plants and shelling percentage.

El-Ganayni (2000), indicated that applying nitrogen fertilizer at the rates of (80, 90, 100 and 110kg N/fed.), caused increases in plant height, number of leaves/plant, leaf area index, number of ears/100 plant, number of rows/ear, number of kernels/row, number of kernels/ear, 100-kernels weight, grain yield/plant and grain yield ardab/fed.

Salem (2000), showed that increasing nitrogen fertilizer levels caused increases in grain yield and its components, plant height, stalk diameter, ear position, ear length, ear diameter, number of row/ear, number of kernels/row, ear weight, grain weight/ear, number of ears/plant and grain yield/plant without inoculation by Biogen.

Allam *et al.* (2001), mentioned that increasing nitrogen levels from 75 up to 105 kg N/fed., revealed significant increases in 100-kernenals weight, grain yield t/fed., nitrogen use efficiency and grain protein content percentage.

Saleh and Nawar (2003), found that increasing nitrogen rates up to 120 kg N/fed., caused increases in plant height, ear height, ear diameter, 100-grains weight, grains yield/fed., and crude protein percentage.

2.3. Effect of plant density

Brown *et al.* (1970), found that grain yield/plant decreased with increased population. The decline in yield/plant with increasing plant numbers was greater in non-irrigated than irrigated corn, leaf area/plant decreased as spacing with in the row was decreased from 46 to 31 and 15cm-and as rows were narrowed from 102 to 51cm.

Hunter *et al.* (1970), used the population of 48.000 62.000 and 72.000plants/ha and row width of 91cm and 46cm. All hybrids increased in grain yield with each increase in population and gave small but significant yield increases to narrowing the row width. LAI increased with increasing plant population on decreasing row width.

Lutz *et al.* (1971), stated that grain yields were increased as the width between rows decreased. Yield were usually higher with late maturity variety planted at a medium on high population. Percentage of moisture in the grains at harvest was not affected by row spacing on plant population but was affected by the hybrid used. Ear weight increased with a decrease in row spacing and plant population and with increased time required for maturity.

Monged (1971), found that plant height was not significantly affected by plants population. The highest yield obtained from 24.000plants/faddan might be mainly due to the greater number of plants/faddan which resulted in greater number of ears.

Rutger (1971), examined seven single crosses and their component inbred lines at population of 37.000, 62.000 and 86.000 plants/ha. He concluded that inbred as a group were more population-responsive than hybrids-Raising plant population from 37 to 86 thousand plants/ha. Increased inbred yields by 48% and hybrid yields by 37% in one experiment, and by 54% and 43%, respectively, in a second experiment. The first population increment increased yields considerably more than did the second increment.

Erbach *et al.* (1972), stated that decreasing the intra- row spacing should be as effective in increasing yields as improving spacing uniformity by decreasing row width. The study indicates that improving intra-row plant spacing may not significantly improve total yield, but plant population was the most important factor in yield.

Abdel-Raouf (1973), found that the population from 16.000 to 20.000 plants for American early and from 20.000 to 24.000 plants for D.C.67 produced the highest grain yields/feddan plant population treatments had in significant effect on plant height, ear position number of leaves/plant and leaf area. Increasing plant populations from 16.000 to 32.000 delayed time of tasselling and silking. Generally, increasing populations decreased both ear length and diameter as well as grain yield/plant. However shelling percentage followed no definite trend with increasing plant density. Plant population of 16.000 was significantly out weighted the other ones in 1000 kernel. Increasing plant density was accompanied by increasing plant stand/faddan.

El-Sayed (1973), found little or no increase in grain yield/faddan as plant population increased from 16 to 32 thousand plants/faddan. The number of ears/plant, ear grain weight and 100-kernel weight decrease by increasing plant population. The number of plants at harvest and silking date were increased with the increase of plant population. Plant height was not significantly affected by plant population.

Beech and Basinski (1974).pointed that at silking, total dry matter was higher under higher population densities, but populations had no effect on mean grain weight. Tasselling silking and maturity occurred in short early variety increased significantly up to 59.300 plants/ha and then levelled off, while the late variety fall significantly with each population increase.

El-Nadi and Lazim (1974), found that the higher plant population (between 60.000 and 100.0000 plants per feddan) in the second experiment gave higher seed yield. The highest yielding variety was V_1, while V_2 ranked second with a lower increase in yield with increasing plant density. Higher seed yields were associated with greater number of pods per plant more seeds per pod, higher 1000-seed weight taller plants and more modes per plant. They also added that periodic counts of flowers and pods mode during the two seasons showed that these attributes were not affected by plant density.

Vez (1974), reported that increasing populations resulted in a slight delay in flowing increase in grain moisture content at harvest decrease in 1000-kernel weight and in the number of grains/plant.

Whigham and Woolley (1974), reported that high population resulted in mutual shading which reduced the grain yield/plant.

El-Hefnawy (1975), showed that plant population had no effect on grain yield, number of rows/ear and shelling percentage. The maximum grain yield was obtained from 24.000 plants/faddan. He found positive and highly significant correlation between LAI and grain/yield/faddan. Increasing population increased LAI and the number of plants at harvest. However, decreasing plant population increased plant height, ear weights, ear length and diameter and 1000-kernel weight.

Ibrahim (1976), showed that means of grain yield/faddan appeared to be higher in case of 20.000 followed by 30.000 plants/faddan. Increasing plant population was accompanied by decrease in ear length and diameter, number of rows/ear, shelling percentage, 1000 kernel weight and grain yield/plant.

Bonsu (1977), stated that sowing sesame at higher densities of 47 and 93 thousand plants/ha increased leaf area index, crop growth rate and dry matter of shoot. Both plants height and seed yield were not influenced by the higher densities of 47 and 93 thousand plants/ha. He also added that plant density of 47 or 93 thousand plants/ha decreased the number of branches per plant number of podding nodes per plant, number of pods per plant and the number of mature seeds per capsule than lower densities of 23 and 31 thousand plant/ha. Plants sown at lower populations of 23 and 31 thousand plants/ha gave their first pods at lower heights. The results also showed that 1000-seed weight was not affected by spacing.

Eraky *et al.* (1980), reported that increasing plant population from 20 to 30 thousand plants/faddan caused a reduction in ear length, rows number/ear grain number/row, grains number/ear, 1000 grain weight, shelling percentage and grain yield/plant while the plant density increased number of ears/plant and grain yield/feddan. However, plant density had no significant effect on ear diameter.

Khalil (1980), recommended 70000 plants per feddan for the highest seed yield.

Abu Hagaza (1981), reported that narrowing plants spacing increased 1000-seed weight, harvest index and decreased oil percentage.

Khalil and Abu Hagaza (1981), concluded that 300.000 to 470.000 plants per feddan gave the highest seed and oil yields.

Gupta (1982), indicated that two branched sesame cultivars sown at 5kg/ha in row 30 cm apart were either left without thinning on the seedlings in a row were thinned to a spacing of 7.5, 15, 22.5 or 30 cm. Plants grown at 30 x 15 cm gave the highest seed yields. Increased between plant spacing progressively delayed flowering and maturation as well as increased the number of branches and capsules/plant, effects on plant height were inconsistent.

Kamel *et al.* (1983). conducted field trials in (1978-80). A dehiscent branched sesame cultivar with 1 capsule in each leaf axiland two capsules was grown in rows 20, 30, 40 or 50 cm aport, with plant spacings of 2.5, 12.5 or 22.5cm, and were given 0,36 or 72kg N/ha. Actual plant populations at harvest were 30-50% less than the theoretical values and ranged from 41.000 to 485.000 plants/ha. Data are given on plant height, number of capsules/plant height to 1st capsule, leaf area index crop growth rate plant dry weight seed yield/plant, 1000-seed weight harvest index, seed oil content and seed and oilyield/ha. Differences between treatments were greatest in rows 30 cm a port. Seed and oilyields were the highest with 75kg N/ha and the closest spacing. The optimum population is suggested to be 500.000 plants, a plant height, height to 1st capsule, leaf area index and growth rate were strongly correlated with seed and oilyield.

Salem *et al.* (1983), reported that plant population density had no significant effect on plant and ear heights of maize. On the other hand increasing plant density resulted in decreasing yield/ear and 100 grain weight, but ear length and diameter and number of grains/row were not affected by plant population. Also they added that plant population density had highly significant effect on grain yield/plant, grain yield/fad, which both increased as plant population density increased.

Assey *et al.* (1985), found that root diameter and root weight/plant were gradually increasing with decreasing plant population.

Salwau (1985), studied that one plant/hill increased the yield components and decreased barren and broken plants. On the other hand two plants/hill gave the maximum number of ears, grain and straw yield/fad due to the increase in number of plants per feddan.

Eid *et al.* (1986), found that sowing sesame plants at 10 cm between hills on the two sides of the ridges (60 cm-a parts) and thinning on two plants/hill were increased plant growth and yield characters.

Moursi *et al.* (1986), found that increase in number and weight of capsules/plant, straw yield/plant, the biological, economic with widening distances between plants from 5 to 20 cm.

Narayanan and Narayan (1987), studied three population densities (16, 33, 66 plants/m^2).They found that lower population density had no influence on the number of seeds/capsule and seed size, but the higher density increased the capsule size. Yield increased with increases in the population density. The increase in total yield was attributed to the total number of plants/unit area at higher population density.

Aly (1988), found that increasing number of plant/fad, decreased significantly plant height, ear height, stem diameter, ear/fad. Area, ear length and diameter, number of grains/row ear weight, weight of grains/ear, shelling percentage and grain yield/plant, in whereas, grain yield/fad. Increased by increasing plant population.

Bikram Singh *et al.* (1988), reported that a density of 330.000 plants was necessary to obtained reasonably good yields. With an increase in density from 330.000 to 500.000 plant/ha the number of capsules/plant, number of seeds/capsules and seed weight/capsule decreased significantly. The increase in yield at 330.000 plants/ha over 220.000 plants was34.02% in the three branched cultivars and 37.03% in the cultivars.

Kamel *et al.* (1989), reported that increasing plant density from 35.000 to 70.000 plants/fed reduced root weight, while top yield tended to increase with higher plant density.

Mahmoud *et al.* (1990), reported that planting sugar beet at 20 cm, distance between hills gave the highest sucrose, purity, root and sugar yields. 30 cm. Planting space produced the heaviest root weight and top yield.

Mandal *et al.* (1990), found that the highest seed yield was reported when sesame was grown plant spacing of 30 x 15 cm, i.e. 222.222 plants/ha.

El-Bialy *et al.* (1991), stated that hill spacing had highly significant effect on all maize characters studied, where spacing i.e. lower plant population gave higher averages of stem diameter/ear leaf area, ear length, number of rams/ear, ear weight shilling percentage, weight of grains/plant and 100-grain weight whereas, plant and ear heights and grain yield/fad. were found to increase by increasing plant population.

Taha *et al.* (1991), stated that the lower plant population (35.000 plants/fed.) produced the higher root length, root diameter, root weight and number of leaves/plant. While produced the lower yields of roots tops and yield/fed.

Edris *et al.* (1992), sowing 56.000 sugar beet plants/fed produced the highest sugar yield compared with 42000 to 70000 plants/fed.

El-Geddawi *et al.* (1992), showed that total soluble solids (T.S.S.%), season and purity percentages responded positively to the increase in sugar beet density from 42000 up to 70000 plants/fad.

El-Kassaby (1992) showed that the highest values of diameter and weight of roots were obtained with sowing sugar beet at 30 cm. Between hills (20.000 plants/fed), while the maximum root and sugar yields/fed. Were obtained when sugar beet was sown at 25 cm. Between hills (48.000 plants/fed.).

Esechie (1992), found that grain yield was higher at 48.000 plants/ha. Leaf area index increased with increasing in plant density from 24000 to 74000 plants/ha, but was not related to grain yield.

Royand Biswas (1992), found that the dry weight per cob. Number of grain/cob and weight of 1000-grain were increased with decreasing plant density from 66600 to 33300 plants/ha, while the number of cobs/m^2 was increasing with increasing plant density.

Ahmadi *et al.* (1993), found that yield of maize increased as population increased while kernel weight/plant decreased.

Aly *et al.* (1993), indicated that plant population had highly significant effect on all characters studied i.e. plant height, ear height stem diameter, ear leaf area (Cm^2), ear length ear diameter, number of rows/ear, number of grains/row, ear weight, shelling %, 100-grain weight and grain yield/plant.

Badr *et al.* (1993), found that increased number of plants per faddan (15000 to 30.000 plants/fed.) decreased significantly all growth characters and yield components studied except the average number of rows per ear and 100-kernel weight.

Mokadem (1993), reported that root length was increased with increasing plant population densities from 28.000to 46.600 plants/feddan while root diameter number of leaves/plant, root weight, leaves weight T.S.S.% sucrose % and purity % were increased with decreasing plant population densities reaching its maximum in plant population density of 28.000 plant/fed. Maximum yields of roots tops and sugars were computed when sown sugar beet under plant population density of 35.000 plants/feddan in both seasons.

Tollenuar *et al.* (1994), found that the competitiveness of maize with weeds can be enhanced by increasing plant density.

Kempet *et al.* (1994), found that optimum population was80.000 plants/ha (33600 plants/fed) to attain maximum sugar yield.

Lower (1995) found that sucrose content increased as plant density increased.

Aly *et al.* (1996), found that closer spacing between hills was associated with higher grain yield compared with wider ones.