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SOME ENGINEERING PROPERTIES OF MAIZE PLANTS, EARS AND KERNELS UNDER DIFFERENT IRRIGATION SYSTEMS

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ABSTRACT

An experiment was conducted for two growing seasons at the Experimental Farm of Faculty of Agriculture, Ain Shams University (loamy clay soil), to study the effect of different irrigation systems on some physical-engineering properties of zea maize. Sprinkler, pivot, surface and subsurface drip and modified surface (gated pipes) irrigation systems were selected for this study.

Data revealed that the ear and kernel dimensions, length and width of kernel were better when using sub-surface drip than those under other irrigation systems, while the kernel thickness was not affected significantly due to different irrigation systems. Geometry diameter and spherecity, which may be considered the main criteria for grain separation and sieving operations, show significant effect with different irrigation systems. Ear weight, hectoliter weight of kernels, seed index and kernel coefficient were affected significantly with different irrigation systems or other agricultural . practices tested at the site. These properties are quite important characteristics concerning kernel storage, aeration and drying. Moisture content of kernel and ear, as the grain storage quality parameter was higher under sprinkler irrigation system than that under the other irrigation systems.

Angle of repose, coefficient of friction, shelling energy, broken percent, bruised percentage and germination of kernels were affected significantly with different irrigation systems, while shelling efficiency was not affected significantly with different irrigation systems. On the other hand, the maximum energy required for kernels shelling was 0.85 Joule when using sprinkler irrigation system, while the minimum energy required for kernels shelling was 0.65 Joule under pivot irrigation system.

The lowest value of kernels visible damaged was 4% when using pivot irrigation systems, while the highest value was 13 % sprinkler under irrigation system. On the other hand, the lowest value of kernels invisible damaged was 23% when using pivot irrigation systems, while the highest value was 37% under sprinkler and drip surface or subsurface irrigation systems.

INTRODUCTION

Maize is considered the third cereal crop in the world-wide scale. In Egypt, maize crop represents a vital source of daily human food. However, it plays a vital role in animal feeding. The cultivated area of maize crop in 1997 amounted to 1,938 million feddans according to Agricultural Extension Issue, (1998).

The physical and mechanical properties must be studied for the plants, ears and kernels of maize crop to increase both kernels quality and quantity, where these properties are considered as a good pointer for designing the agricultural machinery such as: planters, harvesters, grain cleaning, grading machines, grain drying, shellers, storage equipment, crushing and milling machines.

Rinke (1953) pointed out that mechanical damage to seed is considered one the principle factors affecting cold testing results for germinations. Bilanski(1966) measured the load and energy required to initiate fractures in corn kernels under gradually increasing load. Stewart *et al.* (1969) found that static and dynamic coefficients of friction of corn grain on surfaces of metal and concrete increased by increasing the moisture content of grain but if the moisture content of grain increased than 13%, the friction coefficients were decreased. Mohsenin(1970) studied that in certain applications where both shape and size affect the process, the relationships can be expressed by a single, two dimensional system as follows: I = f (sh, s) where "I" is an index influenced by both shape "sh" and size "s". In other applications, the index "I" may be a function of not only shape and size but also of other parameters as orientation "o", packing "p", firmness "F" . etc, as follows: I = f (sh, s, c, p, F, ...) Chakraverty (1972) reported that the physical properties such as shape, size, volume, surface area, density, color, porosity, etc. for different grains are important in designing different systems of threshing, handling, sorting and drying. He also added that the angle of repose and the friction characters for seeds are important in selecting and designing the shapes of hoppers, grain conveying equipment, storage bins and grain pumping equipment. FAO (1981) classified seeds properties into two group; 1)-Internal properties (varieties-purity of cultivated varieties–viability and germination power–growth vigor), and 2)-External properties (natural purity–volumetric grading, specific gravity–moisture content). Hunt (1976) stated that the shelling of corn kernels from the cobs is significantly affected by cob moisture. In this direction he found a linear relationship between the amount of kernels left on the cob and the cob moisture content for a picker-sheller using the cylinder. Herum and Blasidell (1981) found that breakage susceptibility increased greatly as moisture content of kernels decreased from 14 to 12%. Klenin *et al.*(1985) stated that the strength of the bond between kernels and the cob depends upon the type and variety of crop, its ripening and moisture content. Yaklish *et al.*(1984 and 1986) indicated that there are three types of mechanical injury which are easily identified by Tetrazolium test (TZ); cracks, splits and bruises. The later is typically identified by the presence of dark red speckles. It is very common for an inexperienced analyst to mistake the pit for a mechanical injury. The pit is composed of a group of specialized cells on the abaxial surface of the cotyledons in direct opposition to the seed coat ant pit, and an enlarged layer of cells on the ventral surface of the seed coat. Buyanov and Voronyuk (1985) stated that practical use of the physical and mechanical properties of plants helps planners to determine the size of machines and develop schemes for technological processes, select more appropriate structural materials and improve the strength of individual subassemblies and parts of agricultural machinery. Sitkei (1986) reported that the shapes of the various seeds are generally irregular, and so a very great number of measurement data would be needed to describe them accurately. However, practical measurements show that the various shapes may generally be characterized well by specifying purposely-selected orthogonal axes. The seeds are usually characterized by their length, width and thickness. The dimensions of agricultural products are not uniform, but scatter around a mean value. Therefore, it is necessary to determine the distribution of individual sizes and the mean size on the basis of this distribution. El-Raie, *et al.*(1996) said that in recent years, there has been a general recognition of the need to determine the physical and mechanical characteristics of seeds. This is due to many problems that have been caused the developed mechanization and the application of engineering principles to agricultural production, processing, handling and automation. The properties of these agricultural products must be described in concise engineering terms which an engineer can utilize effectively in the design of the specific machine and its operation or in the analysis of the behavior of the product in handling of the material.

The main objective of this work is to study the effect of different irrigation systems on some physical and mechanical characteristics and quality of maize crop.

MATERIALS AND METHODS

Grain material:

Maize grains (single cross No.10) was submitted from Gene Bank, Agriculture Research Center, Giza and used in this investigation. Normal cultivation practices were followed during 1998 and 1999 growing seasons in the Experimental Farm of the Faculty of Agriculture, Ain Shams University, at El-Kanater (loamy clay soil). Maize was cultivated under different irrigation systems are: Surface and subsurface drip irrigation (GR-drip lines, 8lph/m length at 1.0 bar operating pressure), solid set sprinkler irrigation (sprinkler had two nozzles (3 and 5mm diameter) and 1.5m^3/h discharge at 2.5 bar operating pressure), center pivot sprinkler irrigation(one span with length of 48m and 10m^3/h discharge at 3.0 bar operating pressure), and modified surface irrigation by using gated pipes(The gates were fixed on 6" aluminum pipes and the gate discharge of 4.0m^3/h). Irrigation water was calculated from the following equation, (FAO, 1991):

$$I.R = ((Et_0 \times k_c \times A / E_a) + L.R)\ I$$

Where:

I.R =Irrigation water requirements, m^3/fed/interval,

Et_0 =Reference evapotranspiration, mm/day,

K_c =Crop coefficient, dimensionless (Doorenbos and Pruit, 1977),

A =Area irrigated, fed,

E_a =application efficiency, %,

L.R =Leaching requirements, 10% of I.R, and

I =Time interval, days.

Irrigation water was applied for each irrigation system as shown in Table (1).

Table (1): Applied irrigation water under different irrigation systems.

Irrigation systems	Modified surface	Center pivot	Sprinkler	Drip (surface / subsurface)
Irrigation water, m^3/fed.	2438	2005	2035	[illegible]

Samples as 10 plants each were chosen randomly from each replicates in all treatments 75 days after plantation to determine the plant heights, stem diameter and leaf area. Then all plots were harvested manually at full maturity stage whereas, the harvested ears were subjected to air-drying for 14 days. At the end of drying period, half of maize ears were *shelled manually while other ears were shelled mechanically* by using a corn-shelling machine (Fig.1) available in the Experimental Form of the Faculty of Agriculture, Ain Shams University to measure the shelled kernels quality through the mechanical shelling operation. The shelling machine consists of gathering plate for husked ears. The ears enter the shelling through a feeding hole on the plate when ear pushed by a labor. When the sheller is in operation the spikes draw in ears on the rotating disk, the corn is shelled partly due to the friction between ears and face of the disk, and partly due to the circular movement of the ear itself down in the conical hole. Both the shelled kernels and cobs are drawn and delivered, from a special hole. An electrical motor, 2.2 kW–1420 rpm, was used to operate the sheller. An amount of 10 kilograms of each treated kernels were taken to the Lab for determining some physical and mechanical properties of maize kernels.

Data recorded:

The following properties were measured to evaluate the effect of irrigation systems studied.

A- Some physical properties of maize ears and kernels:

1- Plant, ear and kernel dimensions:

The dimensions of maize plants, ears and kernels (plant height, stem diameter, leaf area, ear length, ear diameter, ear length/ear diameter ratio, kernel length "L", kernel width "W" and kernel thickness "T") were measured by sliding caliper. The mean dimensions of 10 plants, 100 ears and 300 kernels of each irrigation system were measured. The following equations were used to calculate physical properties as follows:

$$Geometric\ diameter\ of\ kernel = (L * W * T)^{1/3} \quad , mm$$

$$Kernel\ volume = 0.5(L * W * T) \quad , mm^3$$

$$Kernel\ sphericity = 100(L * W * T)^{1/3} \quad , \%$$

2-Kernel moisture content:

The moisture content of maize kernels was determined by *using* a sample of 20 grams whole kernels after being placed in forced convection oven set at 105°C for 24 hours.

3-Weight of ear and seed index:

The weight of ear and 100 kernels were recorded.

4-Shelling percent:

The shelling percent of maize was calculated by using the following equation:

$$Shelling\ percent = 100\left(\frac{kernels\ weight\ ,g}{ear\ weight\ ,g}\right)$$

5-Hectoliter weight of kernels:

The hectoliter weight of kernels was measured by weighting one liter of kernels.

6-Kernel coefficient:

The kernel coefficient "C" was calculated from the following equation **(Stanve and Baeve, 1970):**

$$C = [W\ (100 - M)]\ /\ V$$

Where:

C= kernel coefficient, gm/cm^3,
W= weight of 100 kernels, g,
M= kernel moisture content, %, and
V= bulk volume of kernel, cm^3.

B-Some mechanical properties of maize kernels:

1-Shelling energy:

The apparatus shown in Fig.(2) was designed and manufactured in Agric. Eng. Dept., Faculty of Agriculture, Ain Shams University and used for measuring the maximum force required to separate the kernel from the cob. To calculate the shelling energy of kernel the following relation was used:

$$Shelling\ energy = F * L \quad (J)$$

Where:

F= registered force reading, N, and
L= kernel length, m.

2-Static coefficient friction:

The friction coefficient "μ" of kernels sample (100g) was determined by measuring the tangent of the angle "α" at which the kernels sample starts to slide down the slope on steel surface as shown in Fig. 3, to calculate the coefficient of friction the following equation was used:

$$\mu = \tan\ \alpha$$

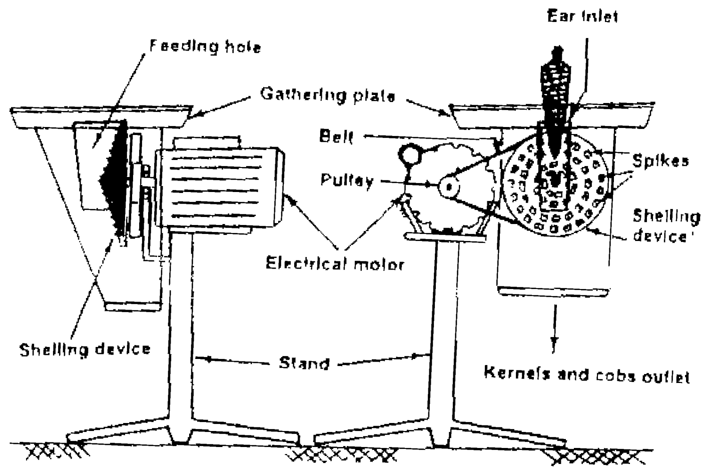


Fig. 1 : The locally small machine fore maize shelling.

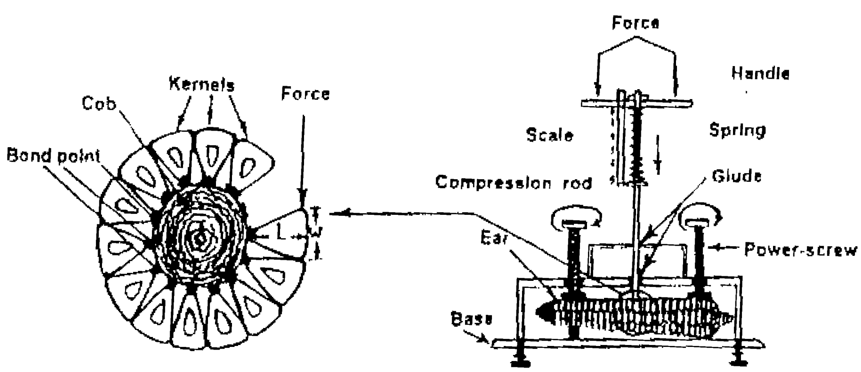


Fig. 2 : Simple apparatus for measuring shelling energy of maize kernel.

3-Natural angle of repose:

The device shown in Fig.(4) was used for measuring the dynamic natural angle of repose "ꜩ of kernels sample placed in a box, flow through an open in its base, whereby a funnel shaped surface is formed in the box and a conical surface underneath. The angles of these surfaces enclosed with the horizontal give the dynamic natural angle of repose.

4-Kernel hardness:

Kernel hardness was determined by using an apparatus, which was designed and manufactured to measure the compressive stress required to fracture the kernel. The construction and dimensions are shown in Fig. 5, to calculate the kernel hardness the following equation was used:

$$Kernel\ hardness\ ,N/mm^2 = \frac{registered\ \ force\ ,N}{contact\ \ area\ ,mm^2}$$

5-Shelling efficiency:

The shelling efficiency was determined by using the following equation:

$$Shelling\,efficiency,\% = 100[W_1/(W_1+W_2)]$$

Where:

W_1= Weight of separated kernels, g ,and

W_2= Weight of non-separated kernels, g.

6-Broken kernels percentage:

The broken kernels percentage was determined by using the following equation:

$$Broken\ \ \text{kernels}\ ,\% = 100\ (W_3/W_1)$$

Where:

W_3= Weight of damaged kernels, g.

7-Bruised kernels percentage:-

The bruised kernels was evaluated by TZ test (Tetrazalium test) and calculated by using the following equation:

$$Bruised\,\text{kernels},\% = 100\left(\frac{Nunber\,of\,counted\,bruised\,\text{kernels}}{total\,stained\,\text{kernels}}\right)$$

8-Visual germination percentage:

Samples of 100 kernels each in four replications were germinated on paper in 12.5 cm pettri dish and incubated at 20°C for a period of 7 days (ISTA, 1996). Only unbroken kernels were used in this test after discarding the broken kernels, which one considered as an inert matter. Visual germination was calculated as follows:

$$Visual\,germination,\% = 100\left(\frac{number\,of\,germinated\,\text{kernels}}{total\,number\,\text{kernels}}\right)$$

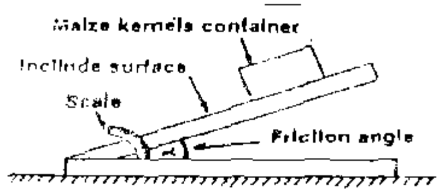


Fig. 3 : Simple device for measuring angle of friction for maize kernels (Sitkei,1986).

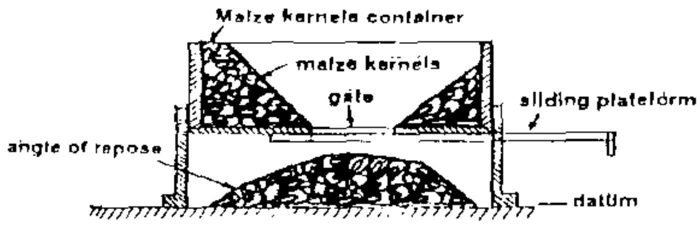


Fig. 4 : Simple device for measuring angle of repose for maize kernels (Sitkei,1986).

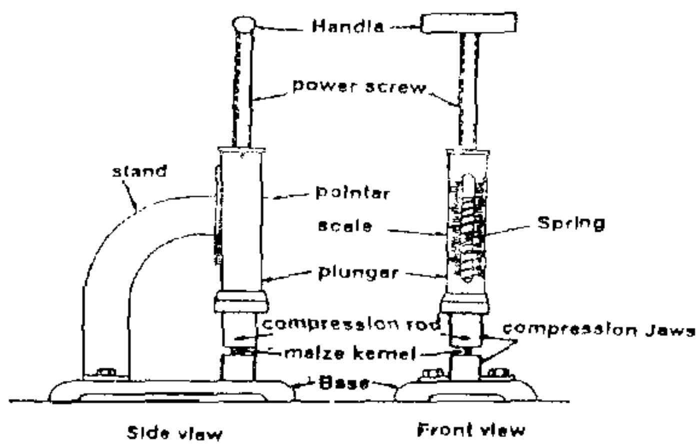


Fig. 5 : Simple device for measuring maize kernel hardness

The data were exposed to proper statistical analysis of the variance of completely randomized design, and L.S.D. test was used for comparison between means (Snedecor, 1956).

RESULTS AND DISCUSSION

1-Effect of irrigation systems on plant height, stem diameter and leaf area:

Data presented in Fig.(6) showed that the irrigation systems had no significant effect on plant height, whereas, the maximum plant height was 327cm when using subsurface drip irrigation system while, the minimum plant height was 284cm under pivot irrigation system. On the other hand, it could be noticed that the irrigation systems had a significant effect on both stem diameter and leaf area. The biggest values of both stem diameter and leaf area were 3.28cm and 1130cm^2 were obtained by using subsurface drip irrigation, while the smallest values were 2.95cm and 1035cm^2 for stem diameter and leaf area respectively were obtained under pivot irrigation system as shown in Figs.(7 and 8).

2-Effect of irrigation systems on some physical properties of maize ears:

A-Main dimensions of ear:

Data presented in Figs. (9, 10 and 11) indicated that the irrigation systems had a significant effect on the main dimensions of ears (length and diameter), but the ratio of ear length to diameter was not affected significantly with irrigation systems. The greatest main dimensions of ears were obtained when using subsurface drip irrigation system (20.2cm length, and 4.8cm diameter), while the smallest main dimensions of ears were obtained by using pivot irrigation system (17.8cm length, and 4.2cm diameter). Decrease of the main dimensions of ears under pivot irrigation system may be due to high water loosing by the evaporation and air drafting.

B-Ear weight:

Data presented in Fig.(12) showed that the irrigation systems had a significant effect on the ears weight. The greatest weight of ears was 226.7g by using subsurface drip irrigation system, while the lowest weight of ears was 202g by using pivot irrigation system. This may be due to the increase in the lost water by evaporation and air drafting under pivot irrigation system.

C-Moisture content of ear:

Data are presented in Fig.(13) indicated that the irrigation systems had a significant effect on the moisture content of ears.

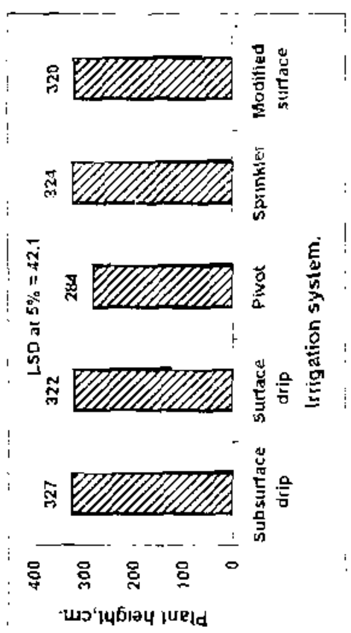


Fig.6: Effect of irrigation systems on plant height .

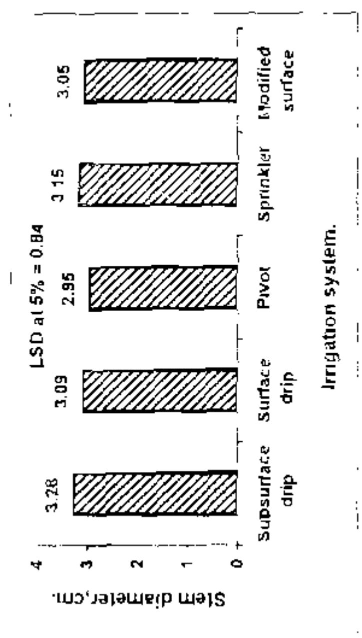


Fig.7: Effect of irrigation systems on stem diameter .

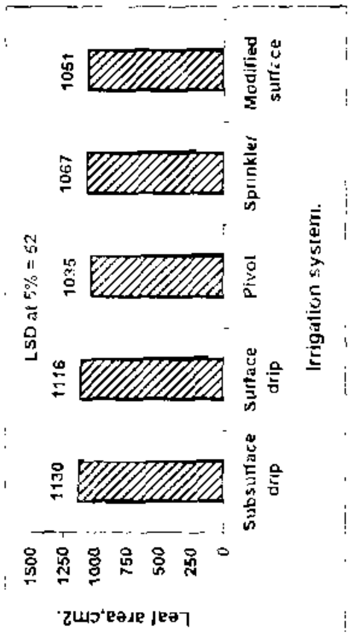


Fig.8: Effect of irrigation systems on leaf area of maize .

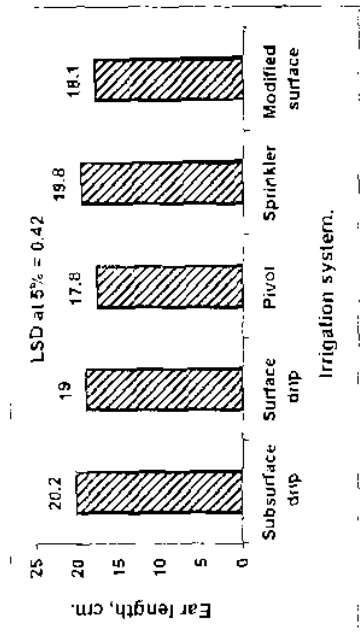


Fig.9: Effect of irrigation systems on ear length .

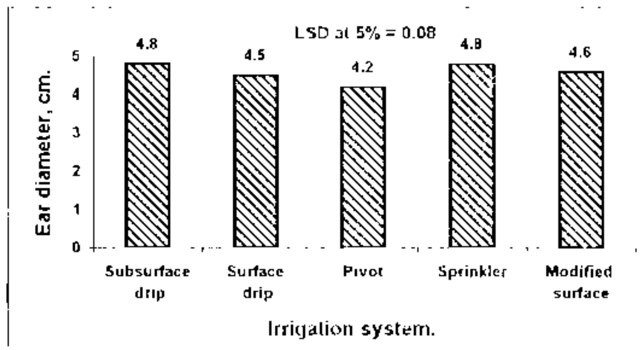


Fig.10: Effect of irrigation systems on ear diameter .

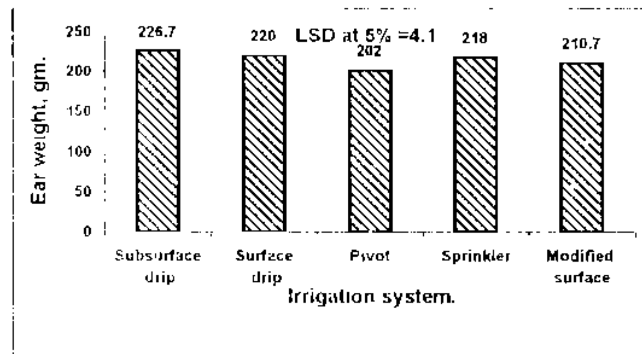


Fig.12: Effect of irrigation systems on ear weight .

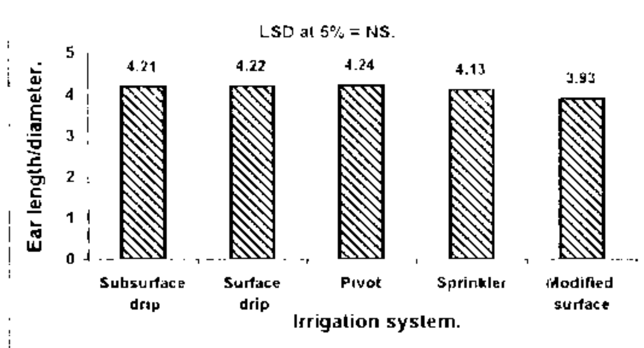


Fig.11: Effect of irrigation systems on ear leath/diameter .

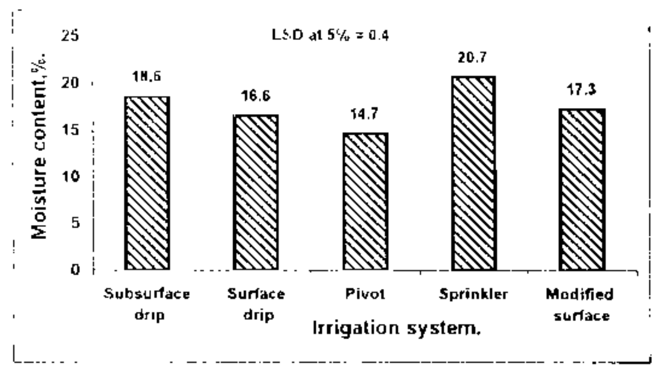


Fig.13: Effect of irrigation systems on moistore content.

The highest moisture content was 20.7% under sprinkler irrigation system followed by subsurface drip irrigation (18.6%) then modified surface irrigation (17.3%) and surface drip irrigation (16.6%), while the lowest moisture content was 14.7% under pivot irrigation system

D-Shelling percentage:

Data presented in Fig.(14) showed that the differences in shelling percentage between the irrigation treatments were not significant. The maximum percentage of shelling was 83.2% under subsurface drip irrigation, while the minimum percentage of shelling was 80.4% under sprinkler or pivot irrigation systems.

3-Effect of irrigation systems on some engineering properties of maize kernels:

3-1-Physical properties of kernels:

A- Main dimensions of kernels:

Data are presented in Figs.(15, 16 and 17) indicated that the irrigation systems had a significant effect on both kernel length and width, while, it had no significant effect on kernel thickness. The greatest length and width of kernel were 10.6 and 8.5mm respectively when using subsurface drip irrigation system, while, the smallest dimensions were 9.1mm length and 7.9mm width by using pivot irrigation system. On the other hand, the kernel thickness for all irrigation systems ranged between 3.8 to 4.0mm. Increase of kernel length and width by using subsurface drip irrigation system may be due to high amount of water in the root zone, less evaporation loss and no leaching the nutrients by run-off and deep percolation.

B-Geometry diameter and kernel volume:

Data presented in Figs.(18 and 19) showed that the biggest values of both geometry diameter and volume of kernel were 7.0mm and 171mm^3 respectively by using subsurface drip irrigation, while, the smallest values were 6.5mm, and 137mm^3 for geometry diameter and kernel volume respectively under pivot irrigation system. Increase in both the geometry diameter and volume of kemel under subsurface drip irrigation system may be due to the increase in the main dimensions of kernel as discussed before.

C-Kernel sphericity, seed index and moisture content:

Data presented in Figs.(20, 21 and 22) indicated that the irrigation systems had a significant effect on sphericity, seed index and moisture content of kernel. The highest value of sphericity was 71.3% under pivot irrigation system while, the lowest value of sphericity was 66% under both subsurface drip and modified surface irrigation systems. High sphericity of kernel under pivot irrigation system may be due to the decrease in the kernel dimensions compared with the other irrigation systems as discussed before.

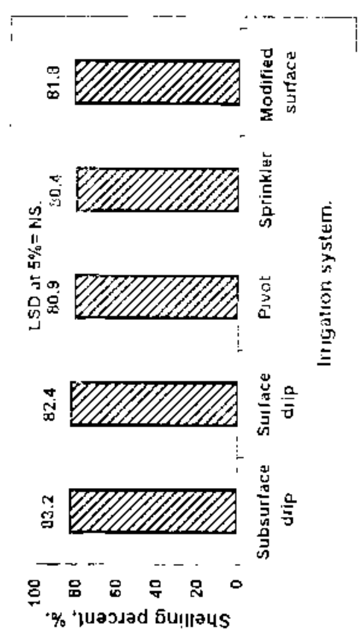


Fig. 14: Effect of irrigation systems on shelling percent .

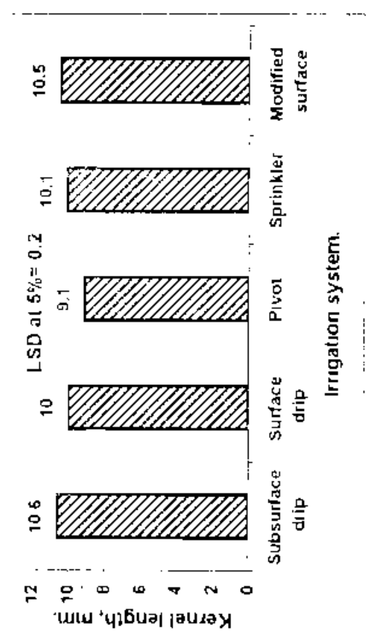


Fig. 15: Effect of irrigation systems on kernel lengh.

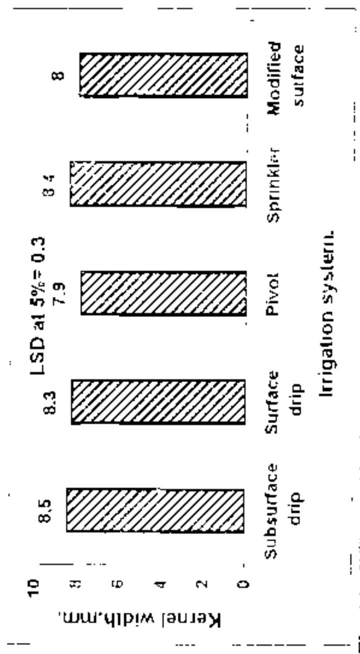


Fig.16: Effect of irrigation systems on kernel width.

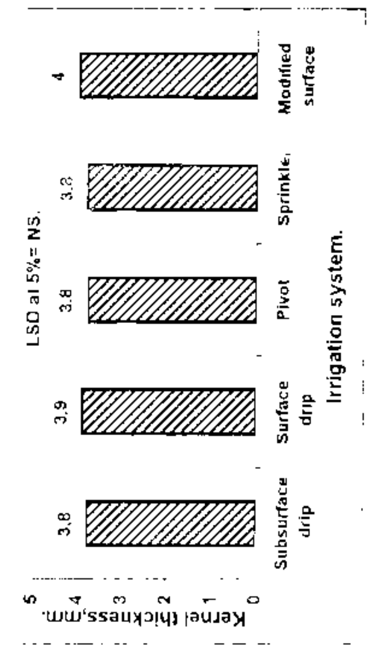


Fig.17: Effect of irrigation systems on kernel thickness.

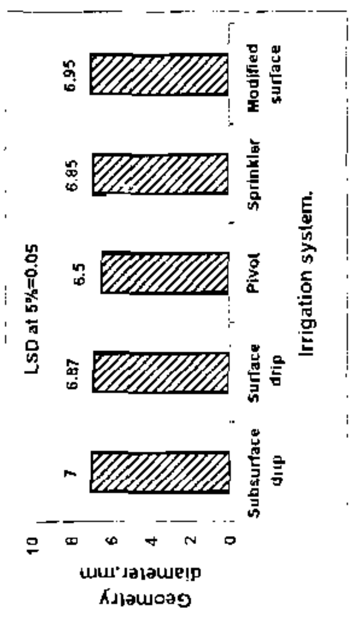


Fig. 18: Effect of irrigation systems on geometry diameter.

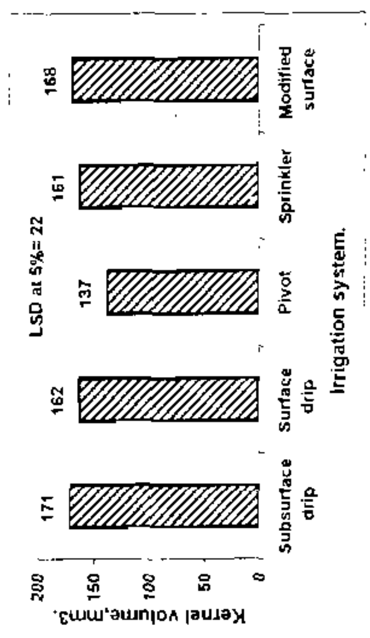


Fig. 19: Effect of irrigation systems on kernel volume .

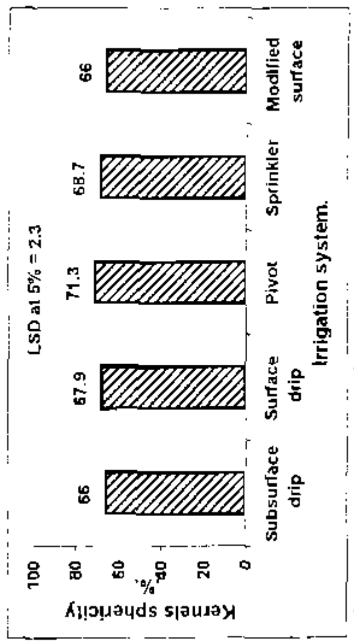


Fig. 20: Effect of irrigation systems on kernel sphericity.

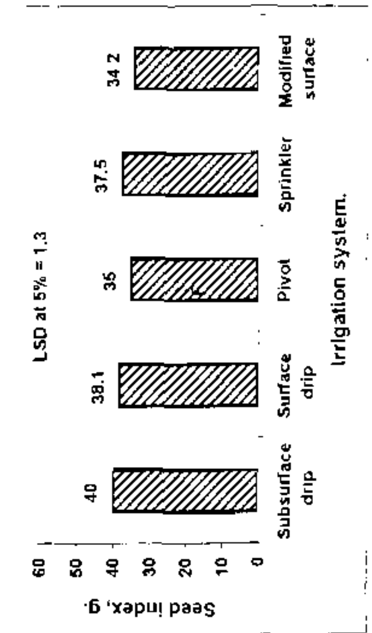


Fig. 21: Effect of irrigation systems on seed index.

Also, it could be seen that the highest seed index was 40g under *subsurface drip irrigation system* while, the lowest seed index was 34.2 by using modified surface irrigation system. This may be attributed to the increase the available water in the root zone under subsurface drip irrigation system and consequently increasing the nutrients uptake and translocation of synthesisate materials to kernels. On the other hand, it could be noticed that the highest moisture content of kernel was 19.7% under sprinkler irrigation system followed by subsurface drip irrigation (16.5%) then modified surface irrigation (14.4%), while the lowest moisture content was 11.4% by using pivot irrigation system. This may be due to the drop in the irrigation water on the maize ears under sprinkler irrigation system and spread through ear covers and therefore increase the kernels moisture.

D-Hectoliter weight and kernel coefficient:

Data presented in Fig.(23) showed that the maximum hectoliter weight was 760gm/l under pivot irrigation system, while the minimum hectoliter weight was 720gm/l under subsurface drip irrigation system. This may be due to the decrease of kernel dimensions under pivot irrigation system and consequently decreasing the pores between the kernels and increasing the number of kernels in one-liter. On the other hand, it could be seen that the kernel coefficient was affected by the irrigation systems. The highest kernel coefficient was 24.06gm/cm^3 when using subsurface drip irrigation system, while the lowest kernel coefficient was 21.67gm/cm^3 under modified surface irrigation system as shown in Fig.(24).This may be attributed to the increase of 100 kernels weight under subsurface drip irrigation compared with the other irrigation systems.

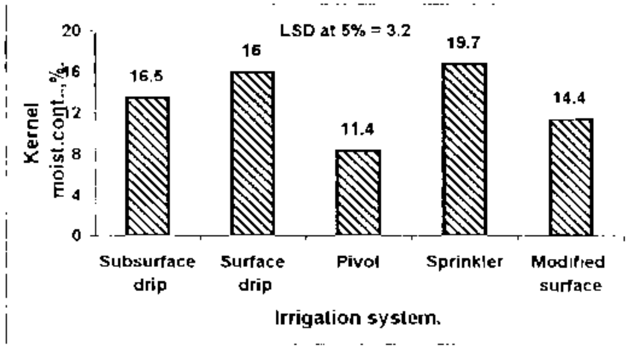
3-2-Mechanical properties of kernels:

A-Angle of repose and coefficient of friction:

Data presented in Figs.(25 and 26) indicated that the irrigation systems had a significant effect on both the angle of repose and coefficient of friction of kernels. The highest angle of repose was 23.2° under pivot irrigation system, followed by surface drip and sprinkler irrigation systems (22.7 and 22.6°, respectively), then subsurface drip irrigation system (20.5), while the lowest angle of repose was 20.3° under modified surface irrigation system The increase in angle of repose may be due to decreasing both the kernel dimensions and the pores between the kernels. Also, it could be noticed that the highest coefficient of friction was 0.344 when using, pivot and modified surface irrigation systems while, the lowest value of coefficient of friction was 0.306 under sprinkler irrigation system. Increase of coefficient of friction of kernels may be attributed to the decrease in kernels moisture content and consequently increasing the surface roughness of kernels.

B-Kernel hardness and shelling energy:

Data presented in Figs.(27 and 28) showed that the irrigation systems had a significant effect on both of kernel hardness and shelling energy.



ig.22: Effect of irrigation systems on kernel moist. content .

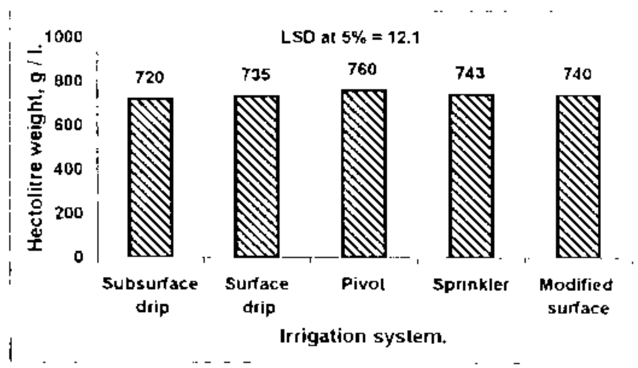


Fig.23: Effect of irrigation systems on hectolitre weight.

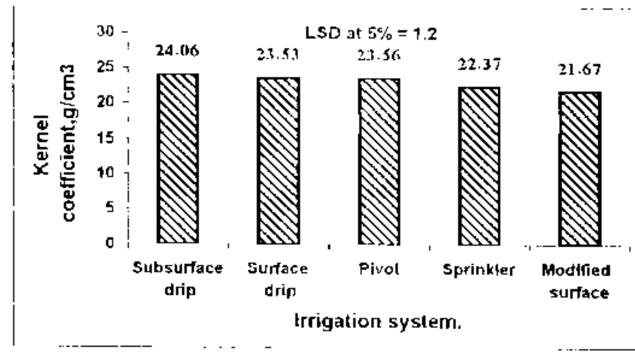


Fig.24: Effect of irrigation systems on kernel coefficient.

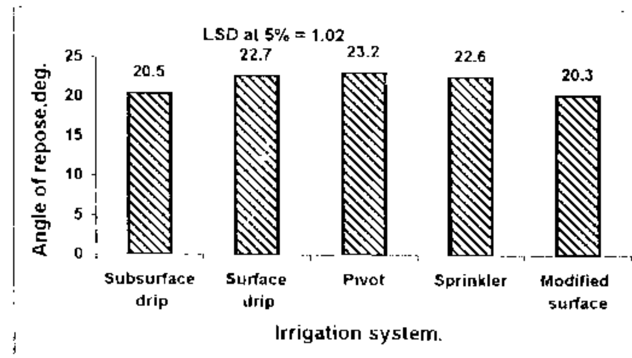


Fig.25: Effect of irrigation systems on angle of repose.

The lowest kernel hardness was 129N/mm^2 when using sprinkler irrigation system, while the highest kernel hardness was 178N/mm^2 when using pivot irrigation system. Reduction of kernel hardness under sprinkler irrigation system may be attributed to the increase in the moisture content of kernels and consequently decreasing the kernel coefficient. Also, from the results in Fig (28) it could be seen that the maximum energy required for kernel shelling was 0.85Joule by using sprinkler irrigation system followed by drip irrigation systems(0.83-0.84J),then modified surface irrigation(0.72J), while the minimum energy required for kernels shelling was 0.65 Joule under pivot irrigation system. The increase in the energy required for kernels shelling under sprinkler irrigation system may be attributed to the high bond strength between the kernels and cob resulted in the high moisture content of kernels compared with the other irrigation systems.

Effect of irrigation system on shelling efficiency, visible and invisible damaged of maize kernels

From the results in Fig (29), it could be seen that the highest shelling efficiency was [illegible]% when using pivot irrigation system while the lowest shelling efficiency was [illegible]% by using sprinkler irrigation system. This may be due to decrease in the moisture content of kernels under pivot irrigation system compared with the other irrigation systems and therefore, the bond strength between the kernels and cob became very weak. Also, data illustrated in Figs (30 and 31) indicated that the irrigation systems had a significant effect on both the visible and invisible damaged of kernels. The highest percent of broken kernels(visible damaged) was 13% by using sprinkler irrigation system, while the percent of broken kernels was ranged between 4-8% under the other irrigation systems. This may be attributed to high moisture content of kernels under sprinkler irrigation system compared to the other irrigation systems. On the other hand, it could be noticed that the percent of invisible damaged of kernels under different irrigation systems was a high, whereas, the maximum value of invisible damaged of kernels was 37% under sprinkler ,surface drip and subsurface drip irrigation sysrems, followed by modified surface irrigation(30%), while the minimum value was 23% under pivot irrigation system. This may be due to low the ear dimension under pivot irrigation system compared the other irrigation systems.

5-Effect of irrigation system on the visual germination of kernels:

Data illustrated in Fig (32) showed that the highest percent of kernels germination was 87% when using pivot irrigation system followed by surface drip and modified surface irrigation systems(67%), while the lowest percent of germination was 53% under sprinkler irrigation system. This may be due to low percentage of both the kernels visible and invisible damaged under pivot irrigation system compared with the other irrigation systems

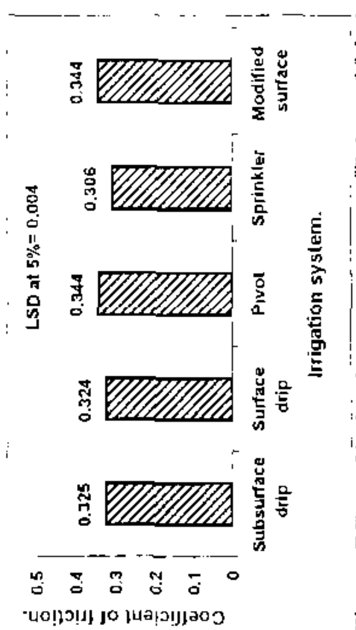


Fig.26: Effect of irrigation systems on coefficient of friction.

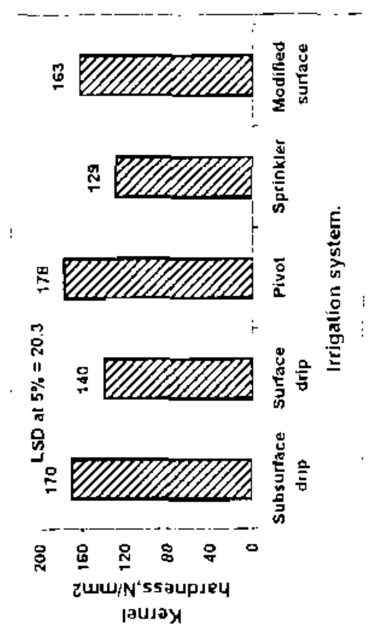


Fig.27: Effect of irrigation systems on kernel hardness .

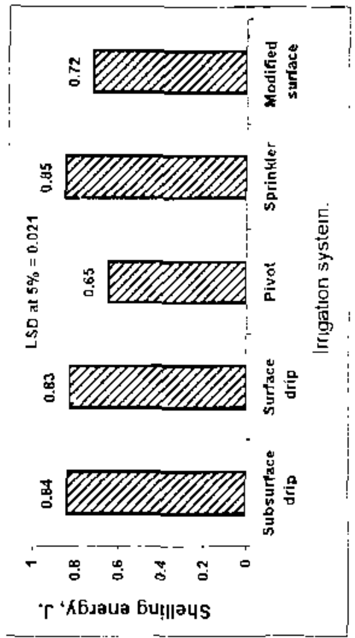


Fig.28: Effect of irrigation systems on shelling energy.

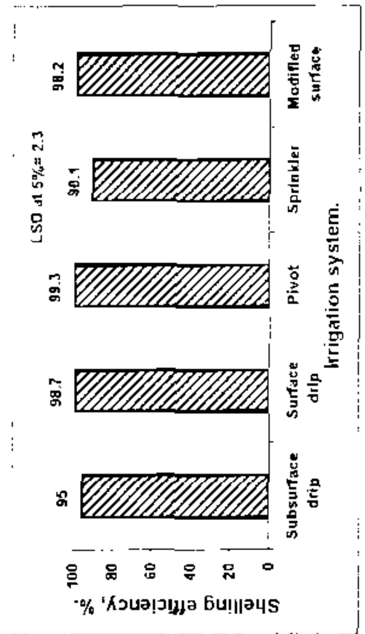


Fig.29: Effect of irrigation systems on shelling efficiency

Fig.30: Effect of irrigation systems on broken kernels.

Fig.31: Effect of irrigation systems on bruised kernels.

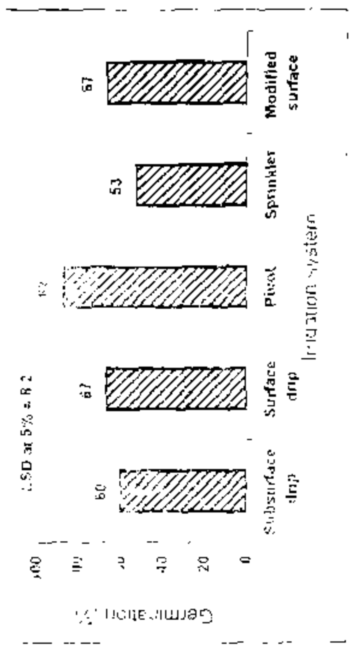


Fig.32: Effect of irrigation systems on % of germination

CONCLUSIONS

The conclusion of this research can be summarized as follows:

1-The biggest values of main dimensions of ear were 20.2 cm length and 4.8 cm diameter when using subsurface drip irrigation system while, the smallest values were 17.8 cm length, and 4.2 cm diameter by using pivot irrigation system.

2-The highest moisture content of ears was 20.7% when using sprinkler irrigation system while, the lowest moisture content was 14.7% under pivot irrigation system.

3-The irrigation system had a significant effect on kernel length, kernel width, geometry diameter of kernel, the kernel volume, and 100 kernel weight, while it had no significantly effect on kernel thickness.

4-The angle of repose, coefficient of friction and kernel hardness were affected significantly due to methods of irrigation while the shelling efficiency was no affected significantly by using the different irrigation methods.

5-The maximum energy required for kernels shelling was 0.85Joule when using sprinkler irrigation system, followed by drip irrigation system (0.84Joule), while the minimum energy required for kernels shelling was 0.65 Joule under pivot irrigation system.

6- The highest percent of broken kernels (visible damaged) was 13% by using sprinkler irrigation system, while the percent of broken kernels was ranged between 4-8% under the other irrigation systems. The maximum value of invisible damaged of kernels was 37% under sprinkler, surface drip and subsurface drip irrigation systems, followed by modified surface irrigation(30%), while the minimum value was 23% under pivot irrigation system.

7- The highest percent of kernels germination was 87% when using pivot irrigation system, while the lowest percent of germination was 53% under sprinkler irrigation system.

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بعض الصفات الهندسية لنباتات وكيزان وحبوب الذرة الشامية تحت نظـــم الـــري المختلفة

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قدرت المساحة المنزرعة بمحصول الذرة في مصر عام ١٩٩٧ بحوالي ١,٩٣٨مليـــون فدان، حيث يعتبر محصول الذرة من أهم محاصيل الحبوب لأنه يستعمل كغذاء للإنسان والحيـوان. لذا يهدف هذا البحث إلى دراسة تأثير خمسة نظم للري (السطحي المطـــور باســتخدام الأنـــابيب المبوبة- الرش المحوري- الرش الثابت- التنقيط السطحي- والتنقيط تحت سطحي) على بعـــض الصفات الطبيعية والميكانيكية لنباتات وكيزان وحبوب الذرة الشامية لما لها من أهمية كبـــيرة فـــي عمليات التداول والتصنيع والتخزين. وقد أجريت هذه التجارب على محصول الذرة الشامية (هجين فردى ١٠) خلال موسمي نمو ١٩٩٨/١٩٩٩ في المزرعة التجريبية لكلية الزراعة- جامعة عيـــن شمس بمحافظة القليوبية (تربة طميية طينية). وبعد حصاد المحصول تم أخذ ١٠كيلو جرام من كل معاملة لتقدير بعض الصفات الطبيعية والميكانيكية لكيزان وحبوب الذرة . وقد أوضحت النتائج أن نظام الري بالتنقيط التحت سطحي حقق أعلى القيم لأبعاد الكوز(٢٠,٢سم للطول ، ٤,٨ سم للقطر) بالمقارنة مع نظم الري الأخرى. بينما أعطى نظام الري بالرش الثـــابت أعلـــى قيمـــة للمحتـــوى الرطوبى للكوز(٢٠,٧%). وقد أثبتت الدراسات أيضا أن هناك تأثير معنوي لنظم الـــري موضــــع الدراسة على الأبعاد الهندسية للحبة والصفات الميكانيكية مثل زاوية التكويم ومعـــامل الاحتكـــاك وصلابة الحبة بينما لم يكن هناك تأثير معنوي على كفاءة التفريط. وكانت أقصى طاقـــة مطلوبـــة لتفريط الحبوب ٠,٨٥ جول تحت نظام الري بالرش يليه نظام الرى بالتنقيط ٠,٨٤ جـــول، بينمـــا كانت أقل طاقة ٠,٦٥ جول تحت نظام الري بالرش المحورى. كما حقق نظـــام الـــري بـــالرش المحوري أقل نسبة للضرر الظاهري والغير ظاهري أثناء عملية التفريط حيث بلغت ٤% للضـــرر الظاهري، ٢٣% للضرر الغير ظاهري، وكذلك حقق أعلى نســبة انبـــات ٨٧%. وقـــد أوصـــت الدراسة باستخدام نظام الري بالتنقيط لانتاج الذرة الشامية لأنه يزيد من بعـــض صفـــات الجـــودة للمحصول علاوة على ترشيد استهلاك مياه الري .