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TABLES must be self-explanatory. They should be typed on separate sheets numbered and carry appropriate title.

LINE DRAWINGS (with photocopies) should be 25 cm wide and drawn in black waterproof ink on Bristol board

*Iraqi J. agric. Sci.*, Vol. IX, 1974.

# THE ULTIMOBRANCHIAL GLANDS OF CHICKENS

## II. HISTOLOGICAL PICTURE AT DIFFERENT AGES

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(Received 12 February 1974)

### SUMMARY

Four different-in-age groups of Single Comb White Leghorn- type chinckens were used to indentify the histological aspects of the ultimobranchial glands of both sexes. At three weeks of age ultimobranchial glands of male and female birds did not show any significant difference other than the presence of more cavities in the histological sections of the males. The glandular cells were grouped in three structures, as previously reported (Al-Jiboori *et al.*, 1972), without signs of hyperactivity. At 19 weeks of age, the glandular cells of the females, but not of the males, exhibited some degree of hyperplasia and hypertrophy. These changes, in the females, were pronounced and accompanied with hyperchromatic nuclei at 36 weeks of age, the age at which egg production is at its peak. Hyperplasia and hypertrophy declined at 52 weeks of age. At this age the ultimobranchial glands of both sexes had large-in-size cavities most of them had septa protruding incompletely into the lumens.

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The results suggested that the glandular cells of the ultimobranchial glands did not undergo, in the growing male chickens, observable variation in the physiological activity during the first year of age. In the female chickens, the activity of the glandular cells followed the patterns of egg production.

## الخلاصـــة

لقد استعملت أربعة مجموعات من دجاج وديكة اللكهورن الابيض لدراســة الطبيعة المجهرية لغدد الـ Ultimobranchial عند بلوغ هذه الطيور أعمارا مختلفة • لقد لوحظ في الاسبوع الثالث بان الشرائح النسيجية للذكور والاناث لا تختلف بصورتها عن بعضها البعض فيما عدا وجود الفجوات التى يفوق عددها في الذكور على عدد الفجوات في الاناث بصورة ملحوظة كما أن الخلايا الغددية في كلا الجنسين لم يبدو عليها اى تغير يشير الى زيادة في الفعالية الفسيولوجية • الا أن هذه الخلايا في الشهر التاسع عشر من العمر ــ وفي الاناث فقط ــ يبدو عليها ما يشير الى زيادة في العدد والحجم والفعالية وتزداد هذه التغيرات حدة في الاسبوع السادس والثلاثين الذى يصل فيه انتاج البيض الى قمته • أن هذه التغيرات تشهد انحدارا في الاسبوع الثانى والخمسين حيث يلاحظ وفي شرائح كلا الجنســين ــ فجوات كبيرة يحتوى معظمها على حواجز غير متكاملة تبرز نحو الداخل • أن نتائج هذه الدراسة تشير الى أن الخلايا الغددية الـ Ultimobranchial في الديكة لا يتم فيها أى تغير ملحوظ في الفعالية الفسيولوجية خلال السنة الاولى من العمر في حين أن الخلايا الغددية للدجاج تظهر فعالية تتناسب مع نمط أنتاج البيض •

## INTRODUCTION

The hypocalcemic and hypophosphatemic effects of the avian and mammalian calcitonin, the hormone which is synthetized and released by the cells of the ultimobranchial tissue, have very well been established by several investigators (Copp *et al.*, 1961; 1967; 1968a; Hirsch *et al.*, 1964; Talmage *et al.*, 1965; Tauber, 1967). In mammals, the cells of the ultimobranchial tissue are closely associated with the thyroid and parathyroid glands (Godwin, 1937; Kingsbury, 1935; Sato *et al.*, 1966). Therefore, these cells have been referred to as "C" cells to indicate that they are the source of calcitonin or thyrocalcitonin (Bussolati and Pearse, 1967; Foster *et al.*, 1964; Pearse, 1966; Pearse and Carvalheira, 1967). The avian ultimobranchial tissue is not embedded in any other gland derived from the branchial pouches. It is surrounded by a capsule and

its glandular cells are cuboidal in shape and arranged in specific structures (Al-Jiboori *et al.,* 1972). The present study was conducted to identify the histological picture of the ultimobranchial glands in male and female chickens in different ages.

## MATERIALS AND METHODS

Four groups of Single Comb White Leghorn-type chickens, six birds each: three males and three females, were selected at random. The groups of birds were 3, 19, 36 and 52 weeks of age. The chickens were sacrificed and the paired ultimobranchial glands were excised and immediately placed in formalin-acetic acid fixative solution. Other adjacent glandular bodies were also removed and placed in the fixative solution in order to use their histological sections for comparison purposes. Hematoxylin-eosion stained sections, ten microns in thickness, were prepared from the fixed tissues as described by Al-Jiboori (1971).

## RESULTS

The ultimobranchial glands of the 24 birds used in this study were found lying in the neck region posterior to the thyroid and parathyroid glands and close to the origin of the carotid and subclavian arteries (Figure 1). They were identified as pinkish oval bodies whose colour is believed to be due to rich blood supply. General examination of the histological sections, of all ages, revealed the presence of more cavities in sections of the males than in those of the females. The cavities were of different sizes. The small cavities were lined with cuboidal epithelial cells. The height of the lining cells showed gradual decrease as the size of the cavities increased until the lining epithelium of the large cavities became squamous in type. Some of the cavities contained, in their lumens, unidentified secretory material in addition to sloughed cells (Figure 2). The glandular cells were grouped in three structures as previously by Al-Jiboori *et al.* (1972). Although the ultimobranchial and parathyroid glands were separated from each other by capsules of connective tissue, some sections showed clumps of cells whose characteristic features were close to those of the parathyroidal cells (Figure 3).

Ultimobranchial sections of both male and female birds at 3 weeks of age showed no histological differences, which could be attributed to sex, other than what has been mentioned above. The appearance of the glandular cells did not indicate hyperactivity. However, these cells exhibited some degree of hyperplasia and hypertrophy, in sections of the female birds only, at 19 weeks of age (Figure 3). Pronounced variation was noticed in the histological sections of the female, but not of the male, birds at 36 weeks of age when egg production was at its peak. The secretory cells showed a great deal of hyperplasia and hypertrophy and their nuclei were hyperchromatic (Figure 4). At 52 weeks of age, sections of both sexes showed characteristic features of the cavities described above. Some cavities were very large in size and had septa protruding incompletely into the lumens. These septa were also lined with squamous epithelium. The glandular cells of the female birds only were, to some extent, hyperplastic and hypertrophied (Figure 5).

## DISCUSSION

The location of the ultimobranchial glands, the arrangement of their glandular cells and the presence of capsules surrounding them were found to be in agreement with the finding of Al-Jiboori *et al.* (1972). The isolated clumps or nodules of cells, which were observed in some sections, were very carefully examined. The cells of these nodules were arranged in cords, some of them showed branching. Their general histological appearance was in favour of considering them very closely related to the parathyroidal cells. Presently, a histochemical study is being conducted in order to confirm their origin. These nodules of cells were not noticed neither by Al-Jiboori *et al.*, (1972), nor by Garlich, (1971). Dudley, (1942), claimed that such encapsulated groups of cells were oftenly seen within the ultimobranchial glands of domestic fowels. Furthermore, Hurst and Newcomer (1969) suggested that the accessory avian parathyroidal tissue, including the isolated nodules within the ultimobranchial glands, were sufficiently and functionally active to compensate physiologically for the parathyroids when the latter were surgically removed.

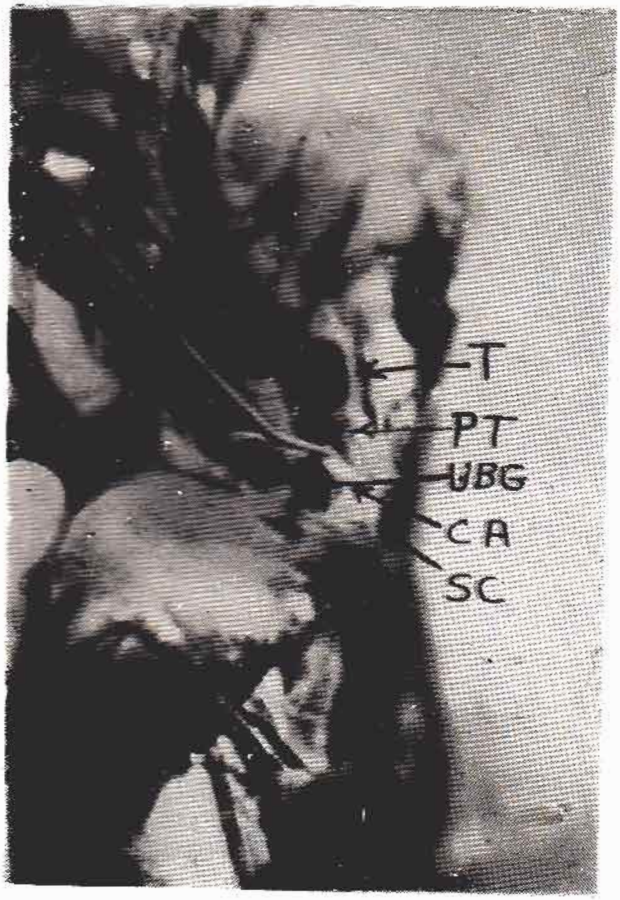


Figure 1. The Ultimobranchial gland of the chicken is located posterir to the thyroid (T) and parathyroid (PT) glands and close to the origin of the carotid (CA) and subclavian (SC) arteries.

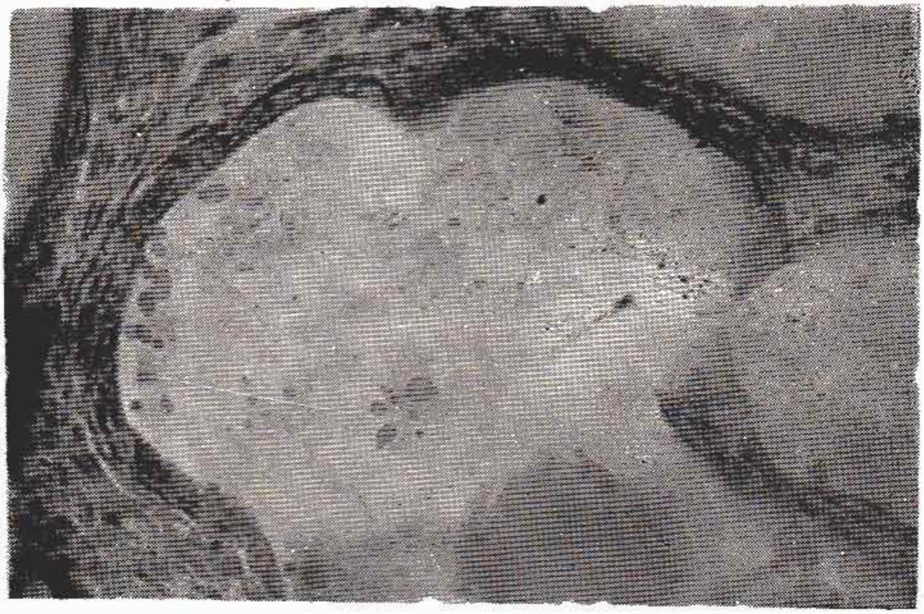

Figure 2. A small cavity in the ultimobranchial tissue of 19 weeks old female chicken. It is lined with a cuboidal epithelium and contains secretory material and sloughed cells (X160).

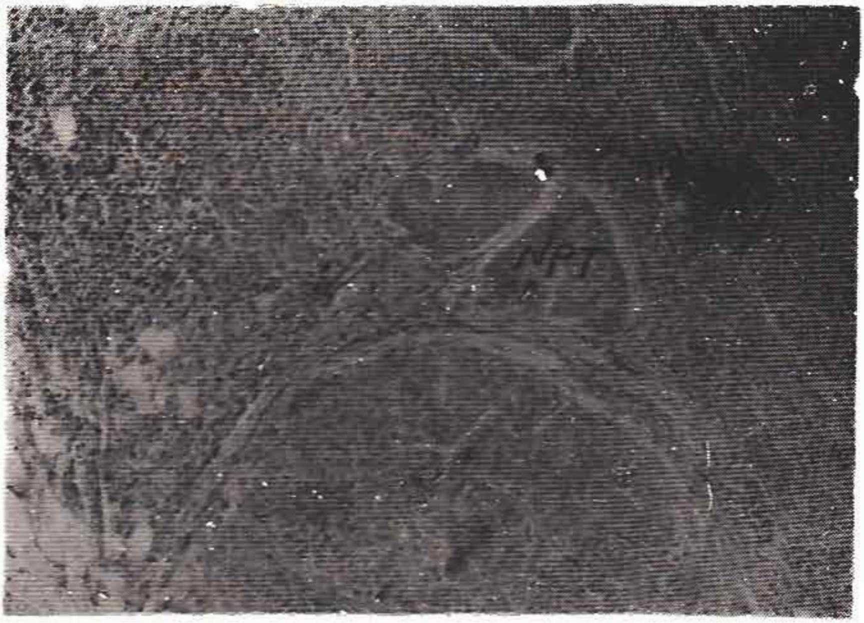


Figure 3. Encapsulated nodules of parathyroid cells (NPT) infiltrating the ultimobranchial tissue of 19 weeks old female chicken (X 64).

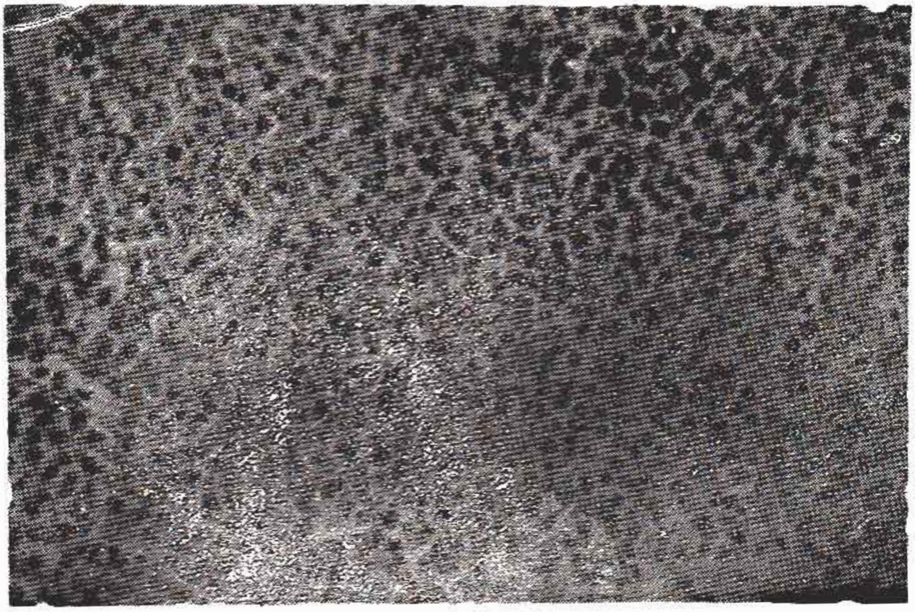

Figure 4. Pronounced hyperplasia and hypertrophy of the glandular cells of the ultimobranchial gland of 36 weeks old female chicken (X 160)

Figure 5. A large cavity, containing a septum, in the ultimobranchial gland of 52 weeks old female chicken. The cavity and its septum are both lined with squamous epithelium. The glandular cells still show some degree of hyperplasia and hypertrophy (X 160).

The histophysiological report of Urist (1967) indicated that hypertrophy of the parathyroidal cells was associated with the peak of egg production. Urist (1967) also reported that total calcium of plasma was higher in the laying hens than in the newly hatched chicks, cockerels, roosters, pullets and non-laying hens. This was attributed to the estrogenic hormones and correlated with the number of growing ova and with the amounts of estrogens released by the ovaries. In the present study, the changes noticed in the glandular cells of the ultimobranchial tissue, at different ages, could be considered as a normal response to plasma calcium level. Increased activity of the ultimobranchial tissue, as reflected by an increase in number and size of the glandular cells, was reported in a number of representative species of vertebrates as a result of induced hypercalcemia (Chan *et al.*, 1969; Copp *et al.*, 1968 b; Gittis *et al.*, 1968; Robertson, 1968). At 3 weeks of age, when the female reproductive system is inactive, the cellular morphological appearance of the female as well as of the male birds, did not indicate hyperactivity. In the males, the ultimobranchial cells retained their histological picture at 19, 32 and 52 weeks of age. In addition to that, the large number of cavities were suggestive of the unimportant role played by the ultimobranchial glands in the males. Garlich (1971) almost reached the same conclusion by surgically removing the glands of male domestic fowls.

The ultimobranchial cells of the female birds showed signs of increased physiological activity at 19 weeks of age when the reproductive organs were brought into cyclic function. The observed hyperplasia and hypertrophy were pronounced at the age of 32 weeks, that is, at the peak of reproductive system activity. At 52 weeks of age, hyperplasia and hypertrophy declined as the egg production declined too.

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# VARIETAL TEST OF COTTON AT ABU-GHRAIB

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(Received 18 October 1973)

## SUMMARY

Three American upland varieties of cotton namely Coker's Carolina Queen, Coker 100A and Stoneville 31352/7 and one Soviet varicty C-450/555 were compared with the commercial variety, Coker 100 wilt, which is also an American upland variety, in a randomized complete block design with five replications experiment for two years 1964-1965. The yield of seed cotton and lint percentage were studied and the following results were obtained:—

There was a highly significant difference in yield of cotton seed among the five varieties in 1965 trial. Coker 100A, with an average yield of 793 kg/donum was found to be superior to Coker 100 wilt which gave a yield of 615 kg/donum. Coker 100A was also significantly higher than the check in lint percentage in 1965 trial. Again the varieties Coker's Carolina Queen, C-450/555 and Stoneville 31352/7 were in that order significantly different from Coker 100 wilt.

The results indicate that there is a possibility of finding a new variety that replaces the commerical one such as Coker 100A and Coker's Carolina Queen.

Since the comparative yielding capacity of a variety is subject to considerable variation due to environmental factors, it is suggested to repeat this experiment for one or two more years in several locations in cotton producing localities of Iraq.

## الخلاصـــة

قورنت ثلاث اصناف من القطن الامريكي : كوكر كارولينا كوبن وكوكر ١٠٠ أ وستون فيل ٧/٣١٣٥٢ وصنف رابع من القطن السوفياتي سي ٤٥٠/٥٥٥ مع الصنف الامريكي المعمم زراعته محليا كوكر ١٠٠ ولت في تجربة القطاعات العشوائية بخمس مكررات خلال سنتي ١٩٦٤ و ١٩٦٥ من حيث حاصل القطن الزهر ونسبة صافي الحلج المئوي وحللت النتائج احصائيا وتم الحصول على النتائج التالية :ـ

تفوق الصنف كوكر ١٠٠ أ على صنف المقارنة احصائيا وعلى مستوى ١٪ من حيث حاصل قطن الزهر في موسم ١٩٦٥ وكان معدل الحاصل للصنفين ٧٩٣ كغم و ٦١٥ كغم/دونم على التوالى ٠

كما تفوق نفس الصنف على صنف المقارنة وفي نفس السنة بنسبة صـــافي الحلج المئوى وعلى مستوى ٥٪ فقط كما تفوق كل من الاصناف : كوكر كارولينا كوبن وسى ٤٥٠/٥٥٥ وستون فيل ٧/٣١٣٥٢ حسب التسلسل التنازلى عـلى صنف المقارنة وعلى مستوى ١٪ من حيث صافي الحلج المئوى ٠

تدل هذه النتائج على وجود امكانية ايجاد اصناف عالية في الانتاج ونسبة صافي الحلج المئوى كالصنفين كوكر ١٠٠ أ وكوكر كارولينا كوبن تحل محل الصنف التجارى كوكر ١٠٠ ولت ٠ لما كانت القابلية الانتاجية لاى صنف معرضة لكثير من التغييرات نتيجة لاختلاف الظروف البيئة خلال السنوات المتوالية في المناطق المختلفة لذا فمن الضرورى اعادة هذه التجربة لسنة او سنتين وفي المناطق المختلفة المشهورة بانتاج القطن في العراق للتأكد من تفوق هذه الاصناف ٠

## INTRODUCTION

The success of cotton production depends more or less on variety grown than on any other single factor affecting yield and quality. Results of large number of trials carried out in different parts of the world indicated that varieties differ to great extent one from another, often to such degree that,

where one may completely fail another may give an excellent crop. (Christidis and Harrison, 1955).

Suitable environmental conditions, as well as, using better cultural practices, may give better yield and quality for certain varieties, however, using a suitable variety will improve the crop without much additional expense. In addition, one must know that where environmental factors fail to improve the yield, a suitable variety may be quite helpful.

The above consideration justifies selection of improved varieties that suit certain areas.

The world production statistics for the period 1948-1952 in cotton yield as given by The F.A.O. Production Yearbook (1971), indicated that U.S.A., India, China, Brazil, U.S.S.R. and Pakistan were the leading countries in cotton area planted with an average lint production of 80.0, 25.5, 35.5, 120.0 and 50.0 kg/donum respectively, Egypt, Sudan, Syria and Turkey came second with average yield of 130.0, 90.0, 70.0 and 62.5 kg/donum respectively. The average production of lint cotton in Iraq for the same period was 35.0 kg/donum, which is considered to be very low. These data indicate clearly that there is an urgent need for improving cotton yield in Iraq by selecting a new variety that suits the Iraqi environmental conditions.

The objective of this study was to compare the seed cotton yield, lint percentage and fiber properties of each of the introduced varieties with that of the only variety grown in Iraq in order to select a replacement for the local variety.

## MATERIALS AND METHODS

Four introduced varieties of upland cotton *(Gossypium hirsutum L.)* were compared with the commercial variety which is also an upland cotton, as a check. These varieties were:—

(1) *Coker's Carolina Queen:* This is an American variety introduced to Iraq from the U.S.A. in 1963. It has a good resistance to Fusarium wilt disease and nematodes, a consistently high producer with a lint percent of 39-41 under average conditions, and staple length of 1/16" to 3/32". It also has excellent fiber and yarn strength (Coker, 1963).

(2) *Coker 100A:* This variety is also an American entry. It has resistance to verticillium and Fusarium wilt, high yielder over a wide range of environmental conditions, ginning turn-out averages from 38-40% lint, staple length 1.1/32" to 1.3/32"; fiber quality is uniform and good micronaire (Coker, 1963).

The above two varieties were introduced by the author from the U.S.A. in 1963.

(3) *C-450/555:* This is wilt resistant salt tolerant to certain extent, high yielder with ginning out-turn of 38-39%, and staple length 30-32 mm. This variety was introduced by the Ministry of Agriculture in 1961 from The Soviet Union. The above three varieties were tested by the auther in 1963 season in an exploratory experiment and they all out yielded Coker 100 wilt and other varieties tested.

(4) *Staneville 31352/7:* This variety was introduced by Al-Juboury from the U.S.A. in 1957 and tested for the first time in 1958 and it appeared to be a high yielder with high ginning out-turn (un-published report). Later, it was tested with other 11 varieties in a varietal trial by Tabrah and Mutwally (1963) and showed seperiority over all other varieties tested including Coker 100 wilt.

(5) *Coker 100 wilt :* is an American variety tested in 1947 for the first time and proved to be superior over the commercial varieties, Acala Rogers, at that time. In 1951, this variety started to replace Acala Rogers in the northern district of Iraq and in 1956 its cultivation covered all cotton areas of this country.

This variety has resistance to Fusarium wilt disease, higher yield with moderately high ginning out-turn of 36—38%; staple length that ranges frvm 11/32" to 13/32", good fiber strenght; easy to harvest and storm resistance.

A randomized complete block design was with five replications. Each variety was seeded in a plot of five furrows, 10 meters long and 83 cm apart in a clay loam soil. Five seeds were put in each hill. The distance between hills was 20 cm. The varieties were isolated from each other by a distance of one meter, while the distance to isolate replications was two meters. The direction of furrows was from east to west and planting was done on the south side, 5 cm below the upper third of the furrows (water line). The dates of planting were on the 2/4 and 29/3 for the two years respectively. The duration of the experiment was two years (1964—1965) at Abu-Ghraib Agricultural Experiment Station, Ministry of Agriculture.

Thinning to 2 plants per hill was made. Plants were sprayed to control spinny bollworm and red spider. Dates and percentages of germination were recorded as well as the dates of first flowering and ball opening. Two pickings were taken from the three central furrows after omitting the plants of two hills from each end of each furrow to find out the yield of seed cotton. The seed cotton for 25 balls, selected randomlly from each plot, was ginned to find out the ginning percentage. The data were analyzed statistically.

## RESULTS

The percentages of germination for all varieties tested, in general, were uniform and good. As for the dates of first flowering and ball opening, they are presented in Table 1. There was no significant difference in these dates and therefore all varities were considered to be behaving the same from the stand point of earliness.

The yearly seed cotton yield, lint percentages and their averages for the two years are shown in Table 2. There was no significant difference among varieties in yield of seed cotton in 1964 trial but there was significant difference at 1% level in trial of 1965. Coker 100A gave an average yield of 793 kg./

donum was found to be superior over the control, Coker 100 wilt, with an increase of 178 kg./donum.

As for the lint percentage, the analysis of variance showed high significant difference for the data of 1964 and only significant difference for 1965 data. It was noticed that the variety Coker 100A which was highly superior in yield over the control variety was also significant in ginning out turn. However, varieties Coker's Carolina Queen, C-450/555 and Stoneville 3152/7 were, in order all highly significantly different from Coker 100 wilt.

Table 1. Dates of first flowering and ball opening in the five varieties tested during the years 1964-1965.

| | 1964 | | 1965 | |
|---|---|---|---|---|
| Varieties | Date of flowering | Date of ball opening | Date of flowering | Date of ball opening |
| Coker 100 wilt | 12/6 | 27/7 | 5/6 | 23/7 |
| Stoneville 31352/7 | 11/6 | " | 4/6 | 24/7 |
| Coker's Cardina Queen | 9/6 | 26/7 | 6/6 | 23/7 |
| C-450/555 | 12/6 | 27/7 | 5/6 | 24/7 |
| Coker 100A | 10/6 | 26/7 | 6/6 | 23/7 |
| Average | 10-11/6 | 26-27/7 | 5/6 | 23-24/7 |

Table 2. Yields of seed cotton and lint percentages for the five varieties tested in 1964—1965

| Varieties | | Yield per donum (kg) 1964 | 1965 | Average | Ginning out-turn (%) 1964 | 1965 | Average |
|---|---|---|---|---|---|---|---|
| Coker 100 wilt | | 589 | 615 | 602 | 36.6 | 33.2 | 34.9 |
| Stoneville 31352/7 | | 583 | 527 | 555 | 39.0** | 36.4** | 37.7 |
| Coker's Corolina Queen | | 563 | 595 | 579 | 39.6** | 37.9** | 38.8 |
| C-540/555 | | 540 | 576 | 558 | 40.8** | 37.6** | 39.2 |
| Coker 100A | | 506 | 793** | 650 | 37.2 | 35.2* | 36.2 |
| L S D | 5% | N.S. | 98 | | 1.16 | 1.48 | |
| | 1% | | 135 | | 2.22 | 2.04 | |
| | C.V. | 4.7% | 12% | | 3.11% | 3.0% | |

* $P < 0.05$

** $P < 0.01$

## DISCUSSION AND CONCLUSION

For determining the practical importance of any variety, the three principle characters of economic importance-yield in seed cotton, ginning out-turn and linit length, all expressed in money value, should be taken into account (Christidies and Harrison, 1955). Fiber quality is important, but on the whole yield is a more important factor influencing the variety grown by farmers than quality.

The results indicate that there is a possibility of finding a new variety(ies) that exceed the predominating variety, Coker 100 wilt in both yield of seed cotton and ginning out-turn. Coker 100A was found to be superior to the check variety in yield of seed cotton and ginning out-turn only in 1965 trial. This was in agreement with that of Shami (1965) who found in 10 varietal trials in Syria (1963—1965) that both varieties Coker 100A and Coker's Caralina Queen were

higher than Coker 100 wilt and the rest of the varieties in seed-cotton and ginning out-turn. However, the second variety proved to be significantly higher in yield than Coker 100 wilt in 1963 and 1965 trials and only apparantly higher in yield in 1964 trial.

When the yield of lint cotton was calculated, Coker 100A yielded 279 kg/donum which is higher than of the check variety with lint cotton of 204 kg/donum. Other varieties mainly Coker's Carolina Queen with lint yield of 226 kg and C-450-555 with 216 Kq/donum were also higher in fiber cotton.

Since the comparative yielding capacity of a variety is subject to considerable variation according to environment, and it is a matter of common observation that a variety exceeding in yield all others in a certain year and a certain locality, may prove quite the reverse in another year in some other district, therefore it is necessary to test these varieties in a number of places for one or two years obviously if a variety excels in yield under a wide variation of conditions its practical importance becomes much higher.

I am indebted for assistance with field work to Mr. Abdul Wahab Abdulla.

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# WATER USE EFFICIENCY OF WHEAT, LINSEED AND COTTON GROWN IN THE CENTRAL REGION OF IRAQ*

**H. N. ISMAIL****

(Revised MS. received 27 April 1974)

## SUMMARY

The water use efficiency (kg of Yield per cubic metre of water) was studied as a part of a major research project on crop's response to irrigation and fertilization. The studied crops were wheat, linseed and cotton. Three levels of water regime were used: high, medium, and low. Crops were fertilized. The water use efficiency ratio for non-fertilized wheat was 0.53, 0.54 and 0.72 kg/m³ water, for non-fertilized linseed it was 6.13, 0.15 and 0.17 kg/m³ water and for non-fertilized cotton it was 0.10, 0.11 and 0.12 kg/m³ water, under high, medium and low water regime respectively. The ratio was greater in wheat than in linseed and greater in the latter than in cotton.

However, when dertilizers were used, the response ratio showes that cotton has a higher ratio than wheat and the latter has a higher ratio than linseed. For a single crop, the response ratio was generally higher for the high water treatment than for the medium water treatment and higher for the latter than for the low water application. This means that crop used water moro efficiently with the use of fertilizers.

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* Part of research work on the response of crops to irrigation and fertilization.

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## الخلاصــة

درست كفاءة استعمال الماء (كغم من الحاصل/م٣ من الماء) لمحاصيل الحنطة والكتان والقطن كجزء من بحث عام عن تأثير الرى والتسميد على انتاج هـــذه المحاصيل الزراعية • استعملت ثلاثة مقادير من مياه الرى (رطبة ومتوسطة وجافة) سمدت المحاصيل بكميات وبمقادير وتشكيلات مختلفة •

اظهرت النتائج ان كفاءة استعمال الماء للحنطة غير المسمدة كانت ٥٣ر٠ و ٥٤ر٠ و ٧٢ر٠ كغم/م٣ ماء وللكتان غير المسمد كانت ١٣ر٠ و ١٥ر٠ و ١٧ر٠ كغم/م٣ ماء وللقطن غير المسمـــد كانت ١٠ر٠ و ١١ر٠ و ١٢ر٠ كغم/م٣ ماء للمعاملات الرطبة والمتوسطة والجافة على التوالى • كانت نسبة الحاصل/الماء اكبر في الحنطة عنها في الكتان واكبر في الكتان عنها في القطن • الا انه بعد استعمال الاسمدة ظهر ان (نسبة الاستجابة) كانت اعلى في القطن عنـه في الحنطـة وفي الحنطة اعلى من الكتان • اما بالنسبة للمحصول الواحد فكانت نسبة الاستجابة في الغالب اعلى في المعاملة الرطبة عنها في المتوسطة وفي المتوسطة عنها فى الجافة • أى أن الاسمدة قد رفعت من كفاءة المحصول لاستعمال الماء •

## INTRODUCTION

Water use efficiency is of a special importance in Iraq where irrigation is a major factor in crop production. Crop water requirements have been the concern of some workers (Boumans *et al.*, 1963, Ismail and Al-Meshhadani 1971 and Al-Nakshabandi and Ismail, 1972).

The water use efficiency (yield/water ratio) for corn in the Central regions of Iraq as was found by Al-Nakshabandi and Ismail (1972) as 0.19 and 0.22 kg/m$^3$ water by using 666 and 527 mm respectively.

Results reported by Slabbers & Doorenbos (1971) for cotton in Iran showed water use efficiency of 0.30, 0.33 and 0.38 kg/m$^3$ water by using 900, 820 and 800 mm water respectively. For sugarbeet the ratio was 3.8 and 3.4 kg/m$^3$ water by using 1020 and 1750 mm water respectively. For alfalfa the ratio was 1.0 and 1.3 kg/m$^3$ by using 2590 and 1270 m$^3$ of water respectively.

According to these results they pointed out that water utilization efficiency seems to favour "dry" treatments.

For rice cultivation, Farrag (1971) reported that water use efficiency was 0.601 and 0.374 kg/m³water by using 13700 and 16850 m³/ha respectively. In this case water was used more efficiently by rice in the lower treatment because of using the transplanted method in the lower treatment and the broadcasting one in the higher treatment.

Zein El-Abdin *et. al.,* (1971) used different amounts of irrigation water on cotton and the water used efficiency was 0.17 and 0.24 kg/m³ water by using 13320 and 3230 m³/ha repectively.

## EXPERIMENTAL PROCEDURES

Wheat, linseed and cotton were studied in the Zafaraniyah experimental station, 10 km south of Baghdad during the years 1961—1970. Three irrigation levels were used, high-crop irrigated at 40% deficient medium-irrigate at 70% deficient and low-irrigated at 85% deficit. Gypsum blocks were placed at the root zone 30 cm for wheat and linseed and 30 & 60 for cotton moisture readings.

The crops were fertilized with two doses of nitrogen and one dose of phosphorous. For wheat and linseed nitrogen was given in the order of 40 & 80 kg/ha of (N) and phosphorous was added 40 kg/ha of ($P_2O_5$). For cotton the two levels of nitrogen were 80 & 160 kg/ha as (N) and for phosphorous it was 80 kg/ha as $P_2O_5$.

Treatments were replicated four times in a split-plot designed experiment. Each crop was tested for three seasons.

## RESULTS AND DISCUSSION

The average results of three years for wheat, linseed and cotton are

presented in tables 1, 2 and 3 respectively. If only moisture levels are taken into consideration the data show that water use efficiency favours the lower level of water used for all the crops. Similar results were reported by Al-Nakshabandi & Ismail (1972) and Slabbers & Doorenbos (1971). The data also show that wheat used more efficiently than linseed and the latter used water more efficiently than cotton.

The analysis of variance shows that the effect of water on yield was significant in most of the seasons for the three crops. However, the water-fertilizer interaction was significant for one seeason only for each crop.

In considering the fertilizers effect on water use effeciency, the response ratio (R.R) reveals that the treatments used water efficiently were medium, high and low water level for wheat, linseed and cotton respectively (tables 1, 2 & 3).

*Water use efficiency of wheat:*

Water use efficiency ratio for wheat was 0.53, 0.54 and 0.72 kg/m$^3$ water for the high, medium and low level of irrigation water respectively under the non-fertilized treatment. The yield/water ratio had increased by increasing amounts of fertilizers within each water treatment. However, response ratio (R.R) shows that water in the medium water level treatment was most efficiently used by wheat (Table 1).

For the highest amounts of fertilizers used the response ratio was 2.32, 1.38 and 1.12 for the medium, low and high water application respectively. The highest response ratio was 3.51 with the lower doze of nitrogen (40 kg/ha) and zero phosphorous. The lowest response ratio (1.12) was with the highest amounts of fertilizers and highest water application used.

*Water use efficiency of linseed*

Table 2 shows the yield/water ratio for linseed. The general trend

favours the lowest level of water application. The ratio was 0.13, 0.15 and 0.17 kg/m³ water for the high, medium and low level of water application respectively for the nonfertilized treatment. When fertilizers were used the ratio increased within each water treatment. The response ratio reveals that water in the low water application treatment was used most efficienty than in other two treatments (Table 2). The highest single response ratio(1.31) and the lowest (0.97) were in the medium water level treatment.

*Water use efficiency of cotton*

The yield/water ratio for cotton was higher in the low level of irrigation water than the medium one and higher in the latter than in the high level of water (Table 3). The ratio was 0.12, 0.10 and 0.10 kg/m³ water for the low, medium and high level of water used respectively for the non-fertilized treatment.

When fertilizers were used the ratio increased respectively within each water treatment, but the ratio was still higher in the low level of water than in the medium and this was higher than in the high water level. For the highest amounts of fertilizers the ratio was 0.25, 0.29, and 0.31 kg/m³ water for the high, medium and low level of water respectively.

The response ratio shows (Table 3) that cotton used water more efficiently in the highest water application than the medium treatment and for the latter than in the low water treatment.

*Crop Comparison*

In using water only the results indicate that water use efficiency ratio is higher for wheat than for liseed and higher for the latter than is cotton. For the non-fertilized treatment under high water level, the ratio was 0.53, 0.13 and 0.10 kg/m³ water for wheat, linseed and cotton respectively. Under medium water level and no fertilizers the ratio was 0.54, 0.15 and 0.11 kg/m³ water for the wheat, linseed and cotton respectiviely. For the low water level and no fertilizers the ratio was 0.72, 0.17 and 0.12 kg/m³ water for wheat, linseed and cotton respectively.

When fertilizers were used, the crop response ratio shows that water was used more efficiently for cotton than for wheat and for the latter than for linseed (Tables 1—3) with only one exception where the medium water level in wheat used water more efficienty after using fertilizers than either linseed or cotton.

The response ratio for any of the studied crops was higher for the high water level treatment than for the medium water level one and higher for the latter than for the low water level treatment. After using fertilizers the crop used water more efficiently than without fertilizers.

However, before recommending any treatment to be used, or making any priorities among crops the economical aspects of water use should be studied and justified.

Table 1: Yield in kg/ha and water use efficiency in kg/m³ and fertilizer treatments for wheat (average of three seasons) and response ratio.

| Field Water used m³/ha | Fertilizer treatment | Yield in kg/ha | kg/m³ Water | R.R |
|---|---|---|---|---|
| | N0 P0 | 2602.0 | 0.53 | |
| | N40 P0 | 2966.5 | 0.60 | 1.82 |
| 4920 | N40 P40 | 3172.0 | 0.64 | 1.42 |
| | N80 P40 | 3276.5 | 0.67 | 1.12 |
| | N0 P0 | 2231.0 | 0.54 | |
| | N40 P0 | 2933.0 | 0.72 | 3.51 |
| 4100 | N40 P40 | 3158.0 | 0.77 | 2.31 |
| | N80 P40 | 3627.5 | 0.89 | 2.32 |
| | N0 P0 | 2363.5 | 0.72 | |
| | N40 P0 | 2693.5 | 0.82 | 1.65 |
| 3280 | N40 P40 | 2946.0 | 0.89 | 1.40 |
| | N80 P40 | 3196.5 | 0.97 | 1.38 |

N 40 = 200 kg of ammonium sulfate/ha.

P 40 = 200 kg of superphosphate (18%)/ha.

N 80 = 400 kg of ammonium sulfate/ha.

*Tablie 2:* Yield in kg/ha and water use efficiency in kg/m³ and fertilizer treatments for linseed (one season) and response ratio.

| Field Water used m³/ha | Fertilizer treatment | Yield in kg/ha | kg/m³ Water | R.R |
|---|---|---|---|---|
| | N0 P0 | 686 | 0.13 | |
| | N40 P0 | 777 | 0.15 | 0.45 |
| 5190 | N40 P40 | 963 | 0.18 | 0.68 |
| | N80 P40 | 1410 | 0.27 | 1.22 |
| | N0 P0 | 650 | 0.15 | |
| | N40 P0 | 912 | 0.21 | 1.31 |
| 4370 | N40 P40 | 1118 | 0.26 | 1.12 |
| | N80 P40 | 1233 | 0.33 | 0.97 |
| | N0 P0 | 605 | 0.17 | |
| | N40 P0 | 853 | 0.24 | 1.24 |
| 3550 | N40 P40 | 1022 | 0.29 | 1.04 |
| | N80 P40 | 1256 | 0.35 | 1.08 |

N 40 = 200 kg of ammonium sulfate/ha.

P 40 = 200 kg of superphosphate (18%)/ha.

N 80 = 400 kg of ammonium sulfate/ha.

*Table 3:* Yield in kg/ha and water use efficiency in kg/m³ and fertilizer treatments for cotton (average of three seasons) and response ratio.

| Field Water used m³/ha | Fertilizer treatment | Yield in kg/ha | kg/m³ Water | R.R |
|---|---|---|---|---|
| | N0 P0 | 1346.0 | 0.10 | |
| | N80 P0 | 2395.7 | 0.11 | 2.57 |
| 12300 | N80 P80 | 3109.9 | 0.25 | 2.20 |
| | N160 P80 | 3369.1 | 0.25 | 1.60 |
| | N0 P0 | 1174.2 | 0.11 | |
| | N80 P0 | 2209.1 | 0.21 | 2.58 |
| 10380 | N80 P80 | 2748.4 | 0.26 | 2.04 |
| | N160 P80 | 3041.7 | 0.29 | 1.55 |
| | N0 P0 | 1018.6 | 0.12 | |
| | N80 P0 | 1634.2 | 0.21 | 1.53 |
| 7860 | N80 P80 | 2273.5 | 0.29 | 1.56 |
| | N160 P80 | 2435.0 | 0.31 | 1.18 |

N 40 = 200 kg of ammonium sulfate/ha.

P 40 = 200 kg of superphosphate (18%)/ha.

N 80 = 400 kg of ammonium sulfate/ha.

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# THE EFFECT OF PLANTING METHOD ON THE YIELD AND SUGAR PERCENTAGE OF SOME VARIETIES OF SUGAR BEETS.

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(Revised MS received 30 May 1974)

## SUMMARY

**Two planting methods; furrows and rows were used for planting five sugarbeet varieties namely Tunarave, K. Interpoly, Poly kuhn, Poly rave and K.A.A., in a split plot experiment with 4 replications at the Agriculture College Station in Abu-Ghraib in 1970 and 1971 seasons.**

**The characters studied were yields of roots in tons per donum, leaf yield and sugar percentage.**

**Both planting methods and sugarbeet varieties varied significantly in the yield of roots and leaves but the differences in sugar contents were not significant.**

**Planting methods and sugarbeet varieties ranked differently in root and leaf yields and sugar contents according to different years.**

**The sugarbeet varieties planted in different planting methods varied significantly in roots and leaf yields. Tunarave gave the highest root yield when grown in furrows and the highest leaf yield when grown in rows.**

**K. Interpoly gave the highest sugar percentage when grown in rows.**

## الخلاصـــة

أجرى هذا البحث بمحطة ابي غريب الاروائية لكلية الزراعة بجامعة بغداد لمدة عامين هما ١٩٧٠ ، ١٩٧١ لدراسة تأثير طريقتى الزراعة الخطوط والمروز على كمية حاصل كل من الجذور والاوراق بالطن وعلى النسبة المئوية للسكريات الكلية بالجذور وقد صممت هذه التجربة باتباع طريقة الالواح المنشقة بأربع مكررات وتتلخص نتائج هذا البحث في الاتي :ـ

١ ـ كان هناك فرق احصائى مؤكد بين طرق الزراعة وبين كل من حاصل الجذور وحاصل الاوراق ولم يوجد أى فرق احصائى بين طرق الزراعة ونسبة السكر في الجذور في جميع الاصناف المدروسة ·

٢ ـ تختلف طرق الزراعة وأصناف البنجر السكرى من حيث حاصل الجذور وحاصل الاوراق ونسبة السكر باختلاف السنين ·

٣ ـ تختلف اصناف البنجر السكرى المزروعة في طرق مختلفة احصائيا في حاصل الجذور وحاصل الاوراق · فقد اعطى الصنف Tunarave المزروع بطريقة المروز أعلى حاصل من الجذور وأعلى حاصل من الاوراق في طريقة الخطوط · ولم يكن هناك فرق احصائى بين أصناف البنجر السكرى المزروعة في كلا الطريقتين في نسبة السكر ·

٤ ـ أعطى الصنف K. interpoly المزروع بطريقة المروز أعلى نسبة سكر ·


## INTRODUCTION

In Iraq the first sugar factory that was built in Mosul in 1959 utilizes beets.. In this northern part of the country environmental factors are favourable for the cultivation of this crop. Whereas, the central and southern parts are favourable for the cultivation of sugar cane. The consumtion of sugar in Iraq during 1967 was estimated about 247100 tons, and it is expected to reach more than 300 thousand tons in 1974. However, only a small percentage of the sugar consumed is locally produced. This work was carried out to investigate the performances of various sugar beet varieties, together with the effect of method of planting on the yields of roots and leaves and sugar content.

## MATERIALS AND METHODS

Two methods of planting namely in rows and furrows were used. In each method, five varieties, Tunarave, K. Interpoly, Poly kuhn, Poly rave and K.A.A. were planted in a split plot experiment with four replications. The plots were located on clay loamy soil at the Experiment Station, College of Agriculture in Abu-Ghraib. Each plot, measuring 6 X 2.7m, consisted of three furrows or six rows. The distance between furrows was 90 cm and between rows was 45 cm. Planting was done by hand at a depth of 4 cm on I November, 1970 and 1971. Seeds were planted in holes on both sides of furrows and the holes were 25 cm apart along the furrows but on rows the seeds were drilled by hand. The amount of seeds per donum was 4 kg for both planting methods. Plots were irrigated in the morning as needed, the irrigation began from planting time until the crop was ripe. Animal manure was used for fertilisation each year at a rate of 3 tons per donum. Hand weeding was done to eliminate weeds from all plots. The central furrows and the two central rows were harvested and the yield of roots and leaves were determined directly on the field, the total sugar percentages were determined by the General Sugar Company in Mosul.

This investigation was repeated for two consecutive years in the same plots with the same five varieties of sugarbeets. The yield of roots and leaves and the sugar percentage were obtained for each treatment for all replications separately and the data were subjected to statistical analysis as described by Leclerg (1962).

## RESULTS

Yields of roots and leaves and sugar percentage of the five varieties of sugar beets included in this study during 1970 and 1971 are given in Table I.

The influence of planting method on yield of roots, leaves and sugar percentage of the five varieties of sugarbeets are presented in Tables 2, 3 and 4 respectively. The yield of roots and leaves varied significantly according to the

planting method and varieties but the sugar percentage did not vary significantly according to the planting method. The variety Tunarave differed significantly in yield of roots and leaves but did not differ significantly in sugar percentage.

The variation in the yield of roots and leaves and sugar percentage according to years, planting method X years, varieties X years and planting method are also given in Table 4.

The influence of year on the yield of roots and leaves and sugar percentage was significant. Planting method X year was significant for root and leaf yields.

## DISCUSSION

One of the major factors which affects yield and quality of the sugarbeet crop in the irrigated area is the use of proper variety with the proper planting method. The method of planting in furrows was the leading method of planting in the yield of roots for all five varieties. This could be attributed to the fact that the roots of plants could grow better under this method due to the favourable soil conditions and the type of the irrigation method (Kreeb, 1964). It was the leading method regarding the sugar percentage except with Poly kuhn and Poly rave and the reason for that perhaps is the quantity of roots became denser in the furrows, because the vegetative growth of plants in this method was much better, consequently photosynthesis increased. Besides, this method was the leading in the yield of leaves except with Tunarave and K. Interpoly and naturally was due to the favourable vegetative growth.

The Tunarave variety produced the highest root and leaf yields and K. Interpoly had the highest sugar content in comparison to Tunarave variety but was not significant in sugar percentage. The variety Tunarave gave the highest yields of roots and leaves from both planting methods but in furrows the yield of roots was higher. Whereas, K. Interpoly gave the highest sugar content when grown in furrows. The sugar percentage for all five varieties

Table I. The influence of the method of planting on the yield of roots, yield of leaves and sugar percentage of five varieties of sugar beets for two years.

| Method of planting | Variety | Yield of roots t/donum | | | Yield of leaves t/donum | | | Sugar percentage | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1970 | 1971 | Average | 1970 | 1971 | Average | 1970 | 1971 | Average |
| Furrows | Tunarave | 16.49 | 12.09 | 14.29 | 2.69 | 2.87 | 2.78 | 15.84 | 15.71 | 15.78 |
| | K. Interpoly | 9.55 | 4.09 | 6.82 | 1.72 | 1.43 | 1,58 | 15.71 | 16.54 | 16.13 |
| | Poly kuhn | 12.77 | 8.24 | 10.50 | 1.94 | 1.89 | 1.92 | 14.60 | 13.83 | 14.22 |
| | Poly rave | 17.11 | 10.19 | 13.65 | 3.13 | 3.08 | 3.10 | 14.33 | 13.48 | 13.91 |
| | K.A.A. | 11.86 | 6.52 | 9.19 | 2.04 | 2.08 | 2.06 | 14.89 | 14.03 | 14.46 |
| Rows | Tunarave | 7.32 | 11.96 | 9.64 | 2.31 | 3.86 | 3.09 | 14.84 | 14.29 | 14.57 |
| | K. Interpoly | 5.12 | 7.83 | 6.48 | 1.58 | 2,22 | 1.90 | 15.43 | 15.26 | 15.35 |
| | Poly kuhn | 5.9 | 7.71 | 6.80 | 1.50 | 1.99 | 1.75 | 15.68 | 15.60 | 15.64 |
| | Poly rave | 6.72 | 8.95 | 7.83 | 1.75 | 2.74 | 2.25 | 14.86 | 14.35 | 14.61 |
| | K.A.A. | 4.89 | 6.91 | 5.90 | 1.58 | 2.27 | 1.93 | 13.84 | 12.83 | 13.34 |
| Rainfall (mm) | | 126.6 | 205.0 | | 126.6 | 205.0 | | 126.6 | 205.0 | |

Table 2. Root and leaf yield of five sugar beet varieties planted by two different methods (1970—1971).

| Varieties | Planting methods root yield t/donum | | | L.S.D. | | Planting methods leaf yield t/donum | | | L.S.D. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Furrows | Rows | Average | 5% | 1% | Furrows | Rows | Average | 5% | 1% |
| Tunarave | 14.29 | 9.64 | 11.96** | 2.44 | 3.30 | 2.87 | 3.09 | 2.98** | 0.54 | 0.73 |
| K. Interpoly | 6.82 | 6.48 | 6.65 | | | 1.43 | 1.90 | 1.66 | | |
| Poly kuhn | 10.50 | 6.80 | 8.65 | | | 1.89 | 1.75 | 1.82 | | |
| Poly rave | 13.55 | 7.83 | 10.74 | | | 3.08 | 2.25 | 2.66 | | |
| K.A.A. | 9.19 | 5.90 | 7.54 | | | 2.08 | 1.95 | 2.01 | | |
| Average | 10.89* | 7.33 | | | | 2.27 | 2.18 | | | |
| L.S.D. | 5% | 3.31 | | | | L.S.D. | 5% | 1.08 | | |
| | 1% | 6.07 | | | | | 1% | 1.98 | | |

* $P < 0.05$

** $P < 0.01$

Table 3. Sugar percentage of five sugar varieties planted by two different planting methods (1970—1971).

| Varieties | Planting methods: Furrows | rows | Average | L.S.D. 5% | 1% |
|---|---|---|---|---|---|
| Tunarave | 15.78 | 14.57 | 15.17 | 2.70 | 4.96 |
| K. interpoly | 16.13 | 15.35 | 15.73 | | |
| Poly kuhn | 14.22 | 15.64 | 14.93 | | |
| Poly rave | 13.91 | 14.61 | 14.26 | | |
| K.A.A. | 14.46 | 13.34 | 13.90 | | |
| Average | 14.90 | 14.70 | | | |
| L.S.D. 5% | 2.35 | | | | |
| 1% | 4.32 | | | | |

Table 4. Mean square values for root and leaf yields and sugar percentage.

| Source of variation | D.F. | Root yield | Leaf yield | Sugar percentage |
|---|---|---|---|---|
| Replicates | 3 | 45.83 | 2.91 | 14.21 |
| Planting methods | 1 | 253.59* | 0.15 | 0.78 |
| Error (1) | 3 | 21.43 | 2.29 | 11.15 |
| Varieties | 4 | 78.17** | 5.16** | 8.57 |
| Planting method X variety | 4 | 16.73 | 0.96 | 5.67 |
| Error (2) | 24 | 11.04 | 0.55 | 5.86 |
| Years | 1 | 34.98** | 3.14* | 3.35* |
| Years X planting methods | 1 | 321.06** | 4.48** | 0.06 |
| Years X variety | 4 | 3.23 | 0.50 | 0.91 |
| Years X variety X planting method | 4 | 1.39 | 0.10 | 0.44 |
| Error (3) | 30 | 1.49 | 0.53 | 0.74 |

* $P < 0.05$

** $P < 0.01$

by both planting methods in 1970 were higher than those of the following year except in the case of K. Interpoly this may be attributed to the relatively higher rainfall (Table 1) during 1971 than that during 1970 (Directorate of Meteorology 1970, 1971). This result is in agreement with those reported by Klapp (1967) and Worker (1963). Variations in root yield, leaf yield and sugar percentage among the sugarbeet varieties planted by both planting methods in both years were observed and this could be attributed to season. Similar results were abtained in other reports (Ulrich, 1952, Caesar, 1959 and Klapp, 1967).

According to this study planting in furrows for highest root yield and planting in rows for highest leaf yield are recommended for Tunarave. While for K. Interpoly planting in furrows is recommended for the highest sugar percentage.

I wish to acknowledge Prof. Ahmed Farouk N. Abdelal, Plant Production Department, College of Agriculture. University of Baghdad, for the revision of this manuscript.

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# EFFECT OF SEEDING DATES ON THREE WHEAT VARIETIES IN THE MIDDLE IRRIGATED REGION OF IRAQ. I. GROWTH AND DEVELOPMENT*

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## SUMMARY

Three wheat varieties, Ajeba 210, Kenya-Gular and Mexipak were planted in five seeding dates, October 14 and 28, November 11 and 25 and December 9 in a split plot design during 1971—72 and 1972—73.

Wheat varieties differed significantly in germination percentage, number of tillers and plant height at the end of the vegetative period and at maturity. Earlier seeding dates had higher germination percentage whereas the later sowing in December 9 decreased the germination percentage for the three wheat varieties.

Ajeba 210 exceeded both Kenya-Gular and Mexipak in the number of tillers. The three wheat varieties produced the highest maximum number of tillers when planted in November 11 and 25. Plantings on October 28 and

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November 11 and 25 prolonged the period to reach the maximum number of tillers.

The rate of increase in plant height during vegetative period was higher in Kenya-Gular and Mexipak than Ajeba, but at maturity Ajeba was the highest. The late sowing on December 9 increased plant height at the end of vegetative period.

Earlier sowing on October 14 reduced the percentage of fertile tillers for Kenya-Gular and Mexipak. Number of days from flowering to maturity was reduced when the three wheat varieties were planted late.

## الخلاصـــة

زرعت ثلاثة اصناف من الحنطة هى العجيبة ٢١٠ ، كيناكولار والمكسيباك في خمسة مواعيد زراعة هى ١٤ ، ٢٨ تشرين اول ، ١١ و ٢٥ تشرين ثانى و ٩ كانون اول باستعمال تصميم الالواح المنشقة .

اختلفت الاصناف احصائيا في نسبة الانبات المئوية ، عدد التفرعات الخضرية ارتفاع النبات في نهاية النمو الخضرى وعند النضـــج .

كانت نسبة الانبات المئوية للاصناف الثلاثة اعلى في المواعيد المبكرة مـن النسبة في الموعد المتأخر (٩ كانون اول) .

وجد ان للحنطة العجيبة قابلية على التفرع اكثر من كل من الكينياكولار والمكسيباك .

اعطت الاصناف الثلاثة اقصى عدد للتفرعات الخضرية عند زراعتها في ١١ و ٢٥ تشرين الثانى .

ادت الزراعة في ٢٨ تشرين اول و ١١ ، ٢٥ تشرين الثانى الى اطالة الفترة اللازمة للوصول الى اقصى عدد للتفرعات الخضرية .

ان معدل الزيادة في ارتفاع النبات خلال فترة النمو الخضرى اعلى في الكينياكور والمكسيباك من العجيبة ٢١٠ ولكن العجيبة كانت الاعلى في ارتفاع النبات عنـــد النضج . ادت الزراعة المتأخرة في ٩ كانون اول الى زيادة ارتفاع النبات في نهاية فترة النمو الخضرى .

انخفضت نسبة التفرعات الخصبة عند الزراعة المبكرة في ١٤ تشرين اول لكل من الكينياكولار والمكسيباك .

قصرت الفترة من الازهار حتى النضج بزراعة الاصناف الثلاثة في المواعيد المتأخرة .

## INTRODUCTION

Common wheat *(Triticum aestivum L.)* is the main winter grain crop planted by farmers in Iraq. On the average 7.50 million donum** are devoted to wheat production with annual rate of 0.140 ton per donum. About 32% of this crop is produced under irrigation in the central and southern regions of the country. Farmers in Iraq plant wheat throughout the period extending from the beginning of October to the beginning of January. Two new wheat varieties, Kenya-Gular and Mexipak were released to the farmers for large scale production. No information available regarding growth and development of wheat when planted in different seeding dates in the region.

This research was designed to study the effect of different seeding dates and the relation of air temperature in each sowing date to germination percentage, tillering, plant height, percentage of fertile tillers and time to maturity for the new varieties Kenya-Gular and Mexipak in addition to the local variety Ajeba 210.

## REVIEW OF LITERATURE

Several investigators mentioned that sowing date affects tillering process of wheat. Choudhry and Khalid (1963) reported that sowing wheat in October gave 38.30% more fertile tillers than sowing in November. Woodward (1956) found that the average number of culms per linear foot for early and late sowings were 32 and 27 respectively. Schlehuber and Tucker (1967) stated that sowing winter wheat too early in fall or too late especially in areas of high day time temperature resulted in poor tillering, while Beech and Norman (1966) using four seeding dates extending from late April to early August declared that the maximum number of fertile tillers was reached at the latest sowings largely because of the effect of sowing date on plant population.

Suput (1966) using winter wheat and Vez (1971) using spring wheat

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** 1 donum = 0.25 hectare.

reported that the late sowing reduced plant height, while Ito and Soga (1968) working with winter wheat and barley varieties found that the length of the main culm increased as sowing date was delayed especially in winter wheat.

Time to maturity had a tendency to converge when wheat varieties were sown in different dates (Florell, 1929). Leonard and Martin (1963) stated that a difference of two months in fall sowing of winter wheat may make a difference in date of ripening of only one week or less. Ito and Soga (1968) reported that spring wheat from warm areas produced heads very early when sown 15 or 30 days before the normal dates at 15 November, while winter wheat from cool areas was affected little by early sowing. Wallen (1965) pointed out that ripening was accelerated by delay of sowing spring wheat.

## MATERIALS AND METHODS

This research was conducted at the College of Agriculture irrigated farm, Abu-Ghraib, University of Baghdad during 1971—1972 and 1972—1973 seasons. Wheat was seeded on a clay loam soil fertilized with 10 tons per hectare of animal manure three months before sowing and irrigated 4 times. The design used was a systematic split plot with four replications (LeClerg *et al.* 1962). The main plot consisted of five seeding dates arranged systematically, the dates in both years were in October 14, October 28, November 9, November 25 and December 9 and designated as D1, D2, D3, D4 and D5, respectively. Three bread wheat varieties: Ajeba 210 (semi-winter) Kenya-Gular C.I. 1425 (spring wheat) and Mexipak 8156 (spring wheat) were arranged randomly as sub-plots.

The rate of seeding was 360 seeds per 1.5 $m^2$ (about 92 kg/ha). Each plot consisted of 6 rows, 5 m long and 30 cm apart. Seeds were drilled by hand in the rows covered with soil at a depth of about 2—3 cm, then irrigated properly. Weeding and irrigation were applied when needed.

Germination percentage was obtained by counting seedings in two rows chosen randomly from the middle four rows during the germination period and shortly before the emergence of tillers on the plants. From one of the middle rows chosen randomly a 50 cm distance was fixed within the row for

counting number of tillers and plant height measurements as explained by LeClerg *et al.* (1962). The counting of tillers and plant height measurements was done 30 days after sowing and thereafter at 15 day intervals till heading time which was recorded on 75% flowering base. Harvesting date was considered as maturity date.

Data regarding germination percentage, final number of tillers, plant height at the end of the vegetative period and at maturity were analyzed statistically as suggested by LeClerg *et al.* (1962).

## RESULTS

***Seed germination, final number of tillers, plant height at the end of vegetative period and at maturity.***

The three wheat varieties differed significantly in germination percentage, final number of tillers and plant height at the end of the vegetative period and at maturity (Table 1). On the average, Kenya-Gular was significantly the highest in germination percentage whereas Ajeba was the highest in number of tillers per 50 cm length and in final plant height at maturity. Mexipak had the lowest number of tillers and plant height at the end of vegetative period and at maturity.

There was no significant difference in germination percentage among the three wheat varieties planted in different seeding dates (Table 2). However, delaying sowing to the fifth date (December 9) reduced germination percentage for all varieties used (Figure 1). Mean daily air temperature during germination periods in different seeding dates were presented in Figure 2.

On the whole the variation in final number of tillers per 50 cm length for the three wheat varieties planted in different seeding dates was highly significant (Table 3). Kenya-Gular had the highest number of tillers at the first seeding date, while Ajeba was the leading at the fourth and fifth seeding dates. Mexipak was the lowest in number of tillers in all seeding dates.

The variation in plant height at the end of vegetative period for the three wheat varieties planted in different seeding dates was significant during 1972—73 season only (Table 4). On the average Ajeba was the highest in plant

Table 1. Germination percentage, final number of tillers, plant height at the end of vegetative period and at maturity for the three wheat varieties in 1971—72 and 1972—73 seasons.

| | 1971—72 | 1972—73 | Average |
|---|---|---|---|
| | Germination percentage | | |
| Ajeba | 71.07 | 75.89 | 73.48 |
| Kenya-Gular | 75.34* | 77.08 | 76.21** |
| Mexipak | 71.38 | 74.83 | 73.19 |
| L.S.D. 5% | 3.28 | N.S | 1.91 |
| 1% | 4.43 | N.S | 2.55 |
| | Final number of tillers per 50 cm | | |
| Ajeba | 73.95** | 90.50** | 82.23** |
| Kenya-Gular | 64.85** | 84.00** | 74.43 |
| Mexipak | 47.40 | 70.25 | 58.83 |
| L.S.D. 5% | 7.02 | 10.32 | 6.13 |
| 1% | 9.46 | 13.90 | 8.17 |
| | Plant height at the end of vegetative period cm | | |
| Ajeba | 54.90** | 54.26** | 54.58** |
| Kenya-Gular | 53.65** | 55.41** | 54.53** |
| Mexipak | 42.47 | 41.51 | 41.99 |
| L.S.D. 5% | 5.65 | 4.80 | 3.63 |
| 1% | 7.60 | 6.46 | 4.82 |
| | Plant height at maturity cm | | |
| Ajeba | 107.41** | 112.89** | 110.15** |
| Kenya-Gular | 101.97** | 109.77** | 105.89 |
| Mexipak | 83.48 | 91.80 | 87.64 |
| L.S.D. 5% | 3.82 | 4.78 | 2.94 |
| 1% | 5.16 | 6.44 | 3.92 |

* $P < 0.05$

** $P < 0.01$

Table 2. The average of the germination percentage for the wheat varieties planted at different seeding dates in 1971—72 and 1972—73 seasons.

| | 1971—72 | 1972—73 | Average |
|---|---|---|---|
| $D_1$ | | | |
| Ajeba | 76.86 | 78.51 | 77.68 |
| Kenya-Gular | 87.33 | 81.46 | 84.39 |
| Maxipak | 80.82 | 79.20 | 80.01 |
| $D_2$ | | | |
| Ajeba | 71.66 | 85.35 | 78.73 |
| Kenya-Gular | 75.52 | 85.35 | 80.43 |
| Mexipak | 70.00 | 83.26 | 76.63 |
| $D_3$ | | | |
| Ajeba | 79.61 | 78.47 | 79.04 |
| Kenya-Gular | 79.75 | 78.41 | 79.08 |
| Maxipak | 78.95 | 77.71 | 78.33 |
| $D_4$ | | | |
| Ajeba | 73.89 | 73.02 | 73.46 |
| Kenya-Gular | 71.69 | 74.34 | 73.02 |
| Mexipak | 71.24 | 72.85 | 72.04 |
| $D_5$ | | | |
| Ajeba | 53.32 | 63.65 | 58.49 |
| Kenya-Gular | 62.43 | 65.84 | 64.13 |
| Maxipak | 55.94 | 61.15 | 58.54 |
| L.S.D. 5% | N.S. | N.S. | N.S. |
| 1% | N.S. | N.S. | N.S. |

N.S. — Not significant.

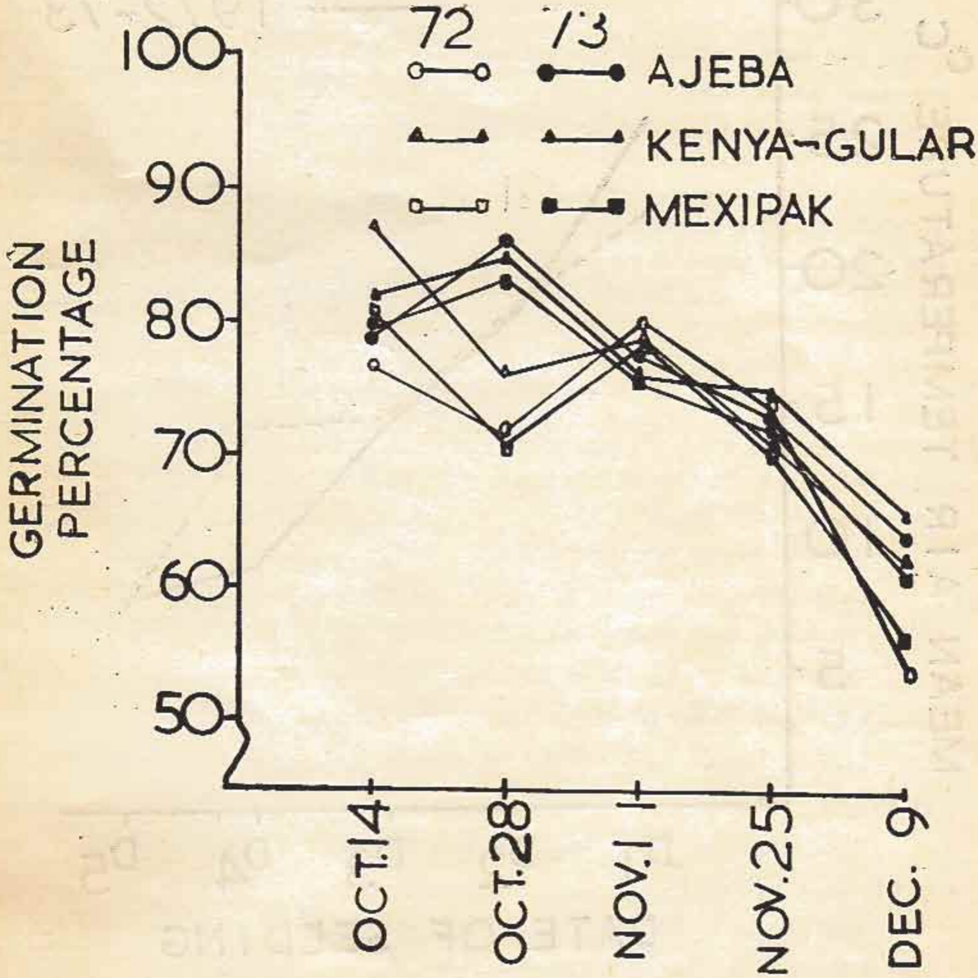


**Figure 1.** Germination percentage for the three wheat varieties planted in different seeding dates in 1971—72 and 1972—73 seasons.

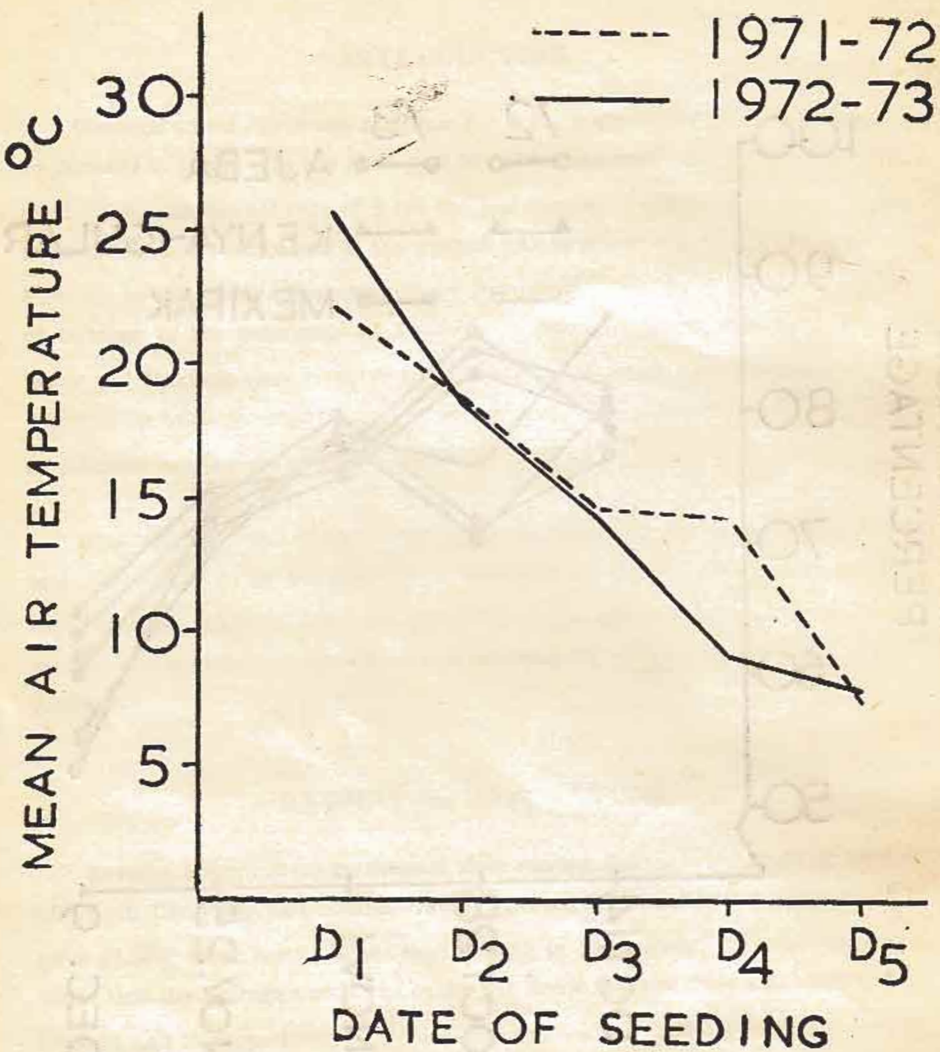


Figure 2. Mean temperature (°C) during germination period (from planting date to tillering) in different seeding dates during 1971—72 and 1972—73 seasons.

Table 3. The average of the final number of tillers per 50 cm length for the three wheat varieties planted at different seeding dates during 1971—1972 and 1972—1973 seasons.

| Dates | Varieties | 1971—72 | 1972—73 | Average |
|---|---|---|---|---|
| $D_1$ | Ajeba | 56.50 | 80.75 | 68.63 |
| | Kenya-Gular | 66.25* | 102.25 | 84.25** |
| | Mexipak | 46.25 | 77.75 | 62.00 |
| $D_2$ | Ajeba | 61.25 | 87.00 | 74.13* |
| | Kenya-Gular | 61.50 | 83.75 | 72.63* |
| | Mexipak | 49.75 | 57.25 | 53.50 |
| $D_3$ | Ajeba | 68.25** | 95.75 | 82.00** |
| | Kenya-Gular | 63.06** | 79.75 | 71.38** |
| | Mexipak | 35.25 | 57.25 | 46.25 |
| $D_4$ | Ajeba | 100.50** | 103.50 | 102.00** |
| | Kenya-Gular | 62.25 | 81.50 | 71.88 |
| | Mexipak | 53.00 | 85.75 | 69.38 |
| $D_5$ | Ajeba | 83.50** | 85.50 | 84.38* |
| | Kenya-Gular | 71.25* | 72.75 | 72.00 |
| | Maxipak | 52.75 | 73.25 | 63.00 |
| | L.S.D. 5% | 15.72 | N.S. | 17.31 |
| | 1% | 21.18 | | 21.73 |

* $P < 0.05$

** $P < 0.01$

N.S. = Not significant.

Table 4. The average of the plant height (cm) at the end of vegetative period for the three wheat varieties planted at different seeding dates in 1971—72 and 1972—1973 seasons.

| Dates | Varieties | 1971—72 | 1972—73 | Average |
|---|---|---|---|---|
| $D_1$ | Ajeba | 55.38 | 61.40** | 58.39 |
| | Kenya-Gular | 45.50 | 50.16 | 47.83 |
| | Mexipak | 40.87 | 34.10 | 37.49 |
| $D_2$ | Ajeba | 48.38 | 50.40 | 49.39 |
| | Kenya-Gular | 56.88 | 56.49 | 56.68 |
| | Mexipak | 42.63 | 50.38 | 46.50 |
| $D_3$ | Ajeba | 47.00 | 66.20** | 56.60 |
| | Kenya-Gular | 51.00 | 62.33** | 56.66 |
| | Mexipak | 35.00 | 45.95 | 40.48 |
| $D_4$ | Ajeba | 51.38 | 44.60 | 47.99 |
| | Kenya-Gular | 46.88 | 47.45** | 47.16 |
| | Mexipak | 39.12 | 32.48 | 35.80 |
| $D_5$ | Ajeba | 72.38 | 48.73 | 60.55 |
| | Kenya-Gular | 68.00 | 60.63** | 64.31 |
| | Mexipak | 54.75 | 44.65 | 49.70 |
| | L.S.D. 5% | N.S. | 10.72 | N.S. |
| | 1% | | 14.44 | |

* $P < 0.05$

** $P < 0.01$

N.S. = Not significant.

height at the end of vegetative period in D1 and D4 while Kenya-Gular was the highest at D2, D3 and D5. However, the late seeding in December 9 increased the plant height at the end of vegetative period of the three wheat varieties especially in 1971—72 season (Table 4).

The difference in the plant height at maturity for the three wheat varieties planted in different seeding dates was not significant (Table 5). On the

Table 5. The average of the plant height (cm) at maturity for the three wheat varieties planted at different seeding dates in 1971—72 and 1972—73 seasons.

| Dates | Varieties | 1971—72 | 1972—73 | Average |
|---|---|---|---|---|
| $D_1$ | Ajeba | 96.97 | 108.87 | 102.92 |
| | Kenya-Gular | 100.45 | 105.03 | 102.74 |
| | Mexipak | 82.50 | 80.29 | 81.40 |
| $D_2$ | Ajeba | 108.62 | 116.59 | 112.61 |
| | Kenya-Gular | 105.19 | 117.63 | 111.41 |
| | Mexipak | 79.91 | 94.48 | 87.20 |
| $D_3$ | Ajeba | 103.19 | 116.39 | 109.79 |
| | Kenya-Gular | 96.17 | 104.63 | 100.40 |
| | Mexipak | 82.00 | 97.54 | 89.77 |
| $D_4$ | Ajeba | 116.38 | 117.19 | 116.78 |
| | Kenya-Gular | 106.13 | 114.41 | 110.27 |
| | Mexipak | 86.58 | 95.71 | 91.14 |
| $D_5$ | Ajeba | 111.90 | 105.43 | 108.67 |
| | Kenya-Gular | 101.94 | 107.13 | 104.54 |
| | Mexipak | 86.40 | 90.99 | 88.70 |
| | L.S.D. 5% | N.S. | N.S. | N.S. |
| | 1% | | | |

N.S. = Not significant.

average Ajeba and Mexipak gave higher plant height at maturity when planted on November 25, whereas Kenya-Gular gave the highest at maturity when planted in October 28.

The plant height at maturity ranked differently in different years, while the seasonal variations in germination percentage, number of tillers and plant height at the end of vegetative period were not significant (Table 6). Varieties

Table 6. Mean square values for germination percentage, number of tillers per 50 cm, plant height at the end of vegetative period and at maturity resulted from the analysis of variance.

| Source of Variation | Germination percentage | Number of of tillers per 50 cm length | Plant height at the end of vegetative period | Plant height at maturity |
|---|---|---|---|---|
| Years (Y) | 333.20 | 11427.00 | 0.09 | 1553.26** |
| Varieties (V) | 114.67 | 5678.40** | 2104.71** | 5716.03** |
| V x Y | 23.85 | 100.24 | 22.13 | 23.41 |
| Variety x Date of sowing (V x D) | 24.24 | 669.70** | 129.26 | 66.35 |
| Y x V x D | 11.80 | 222.70 | 85.63 | 63.24 |

** $P < 0.01$

and varieties x date of seeding ranked similarly in germination percentage, number of tillers, plant height at the end of vegetative period and at maturity according to the variation in years of planting (Table 6).

*Variation in number of tillers per 50 cm length and plant height during vegetative period.*

The variation in number or tillers per 50 cm length for the three wheat varieties planted in different seeding dates are represented in Figures 3, 4, 5, 6 and 7. It is evident from Figures 3, 4, 5 and 6, that Ajeba wheat produced

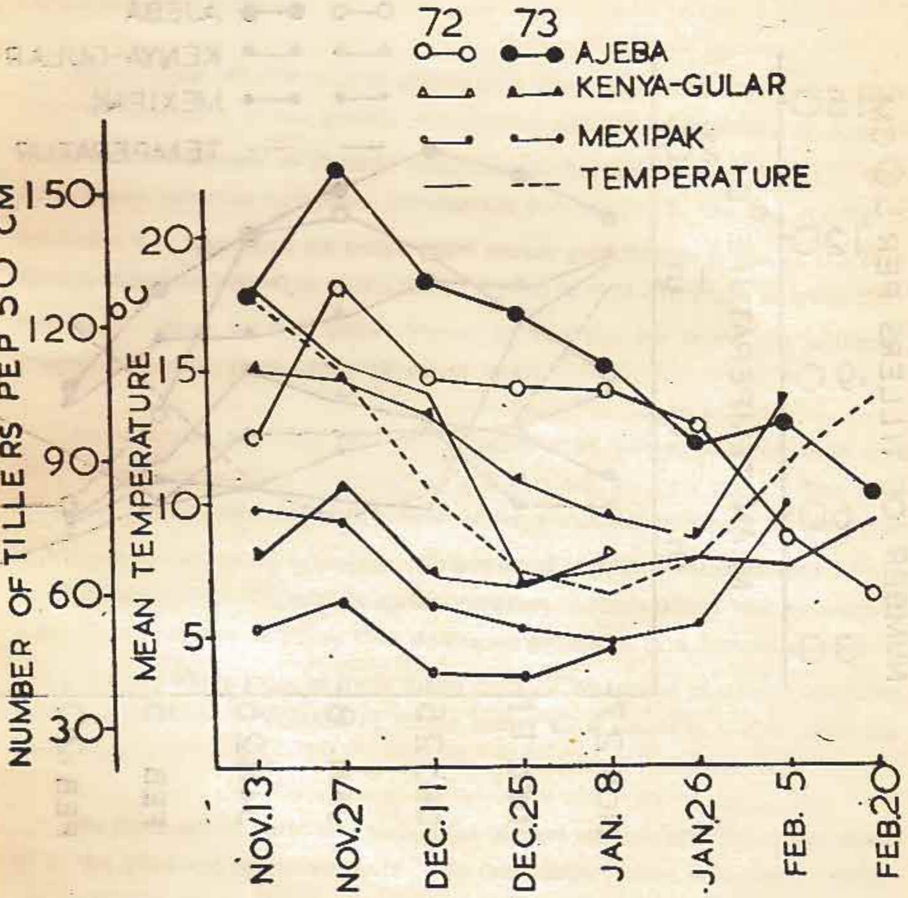


**Figure 3. Number of tillers per 50 cm length during vegetative period for the three wheat varieties planted in the first seeding date in 1971—1972 and 1972—73 seasons.**

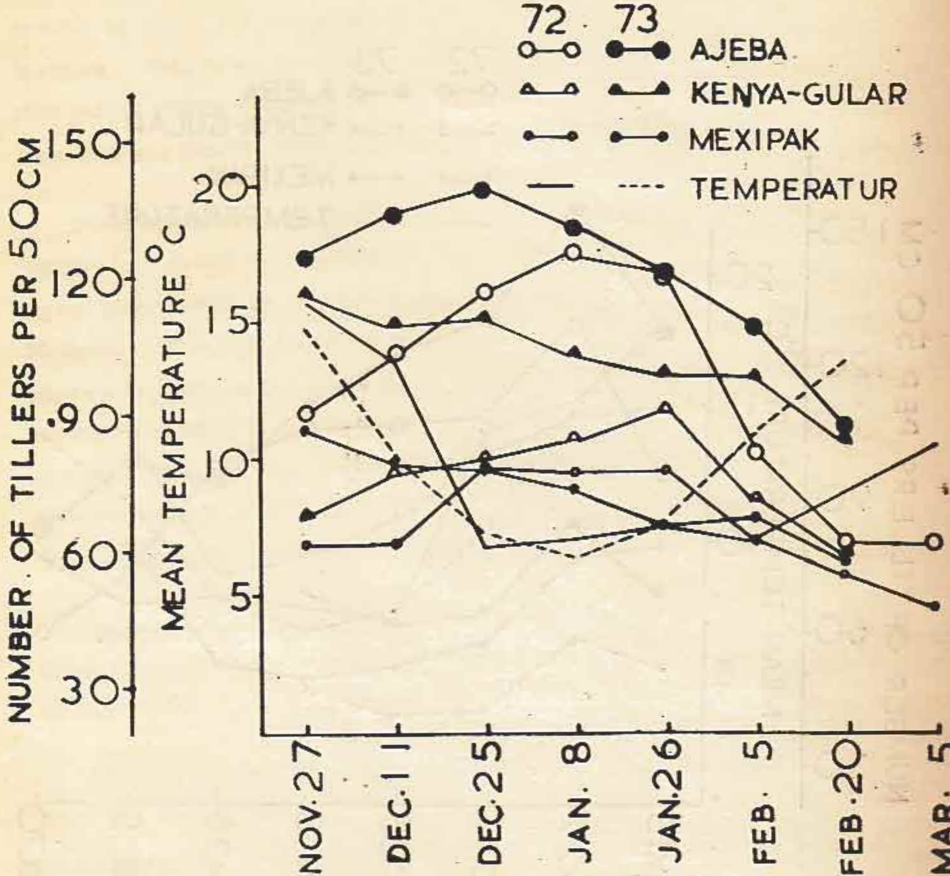


**Figure 4.** Number of tillers per 50 cm length during vegetative period for the three wheat varieties planted in the second seeding date in 1971—72 and 1972—73 seasons.

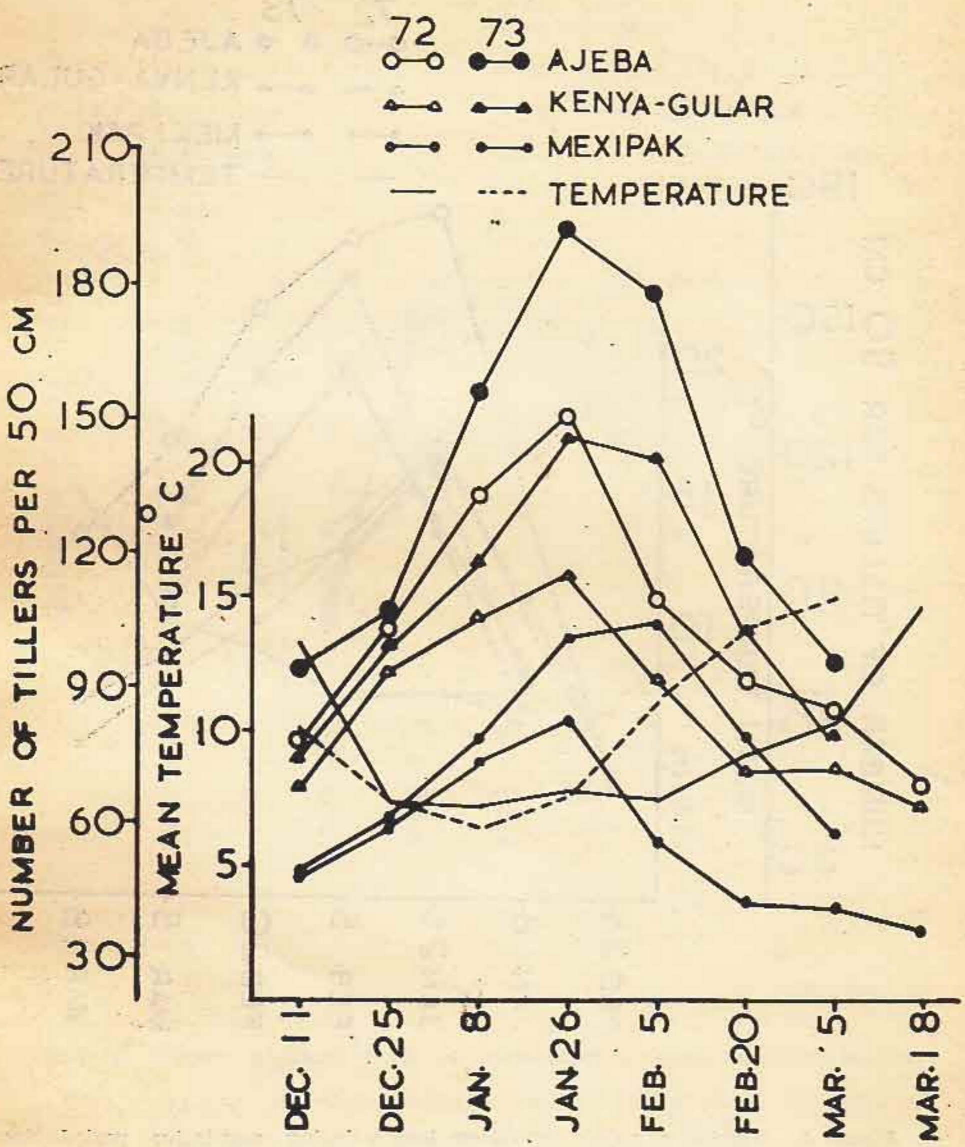


**Figure 5.** Number of tillers per 50 cm length during vegetative period for the three wheat varieties planted in the third seeding date in 1971—72 and 1972—73 seasons.

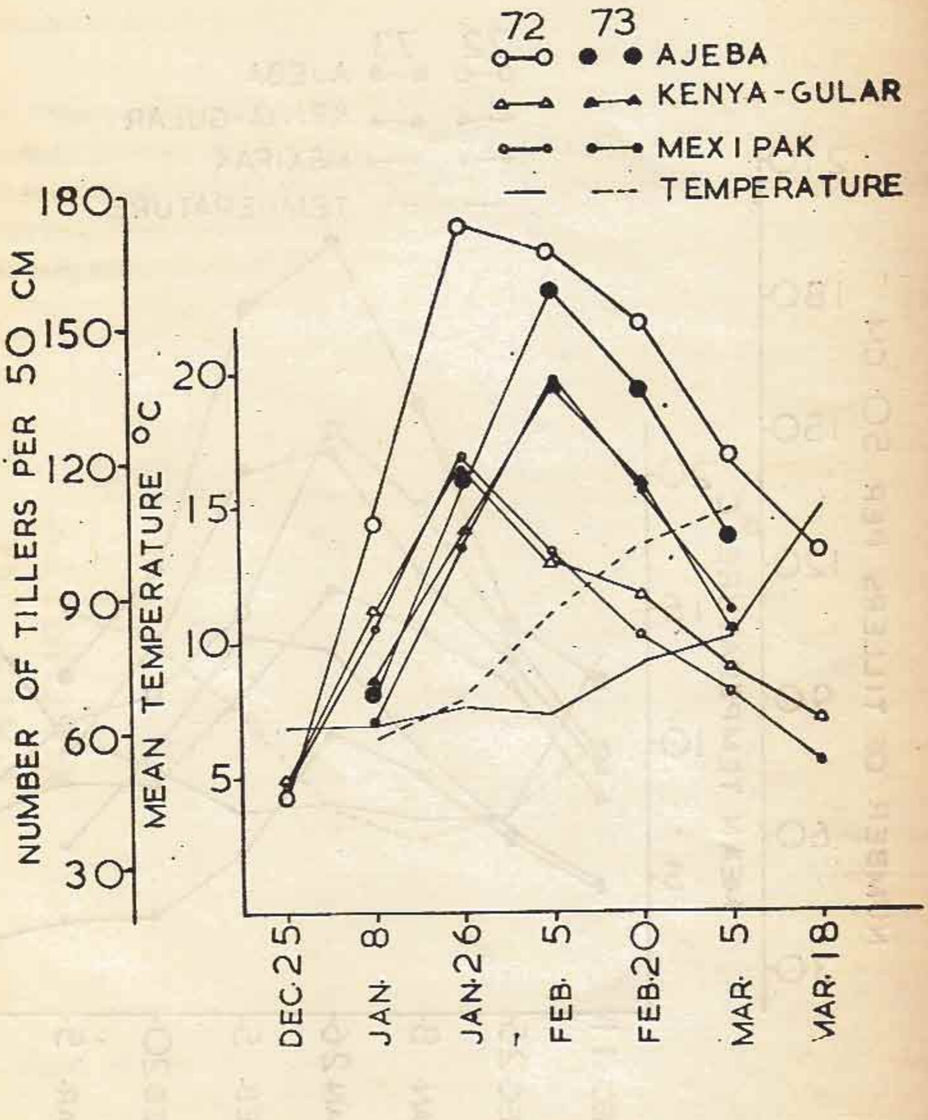


Figure 6. Number of tillers per 50 cm length during vegetative period for the three wheat varieties planted in the fourth seeding date in 1971—72 and 1972—73 seasons.

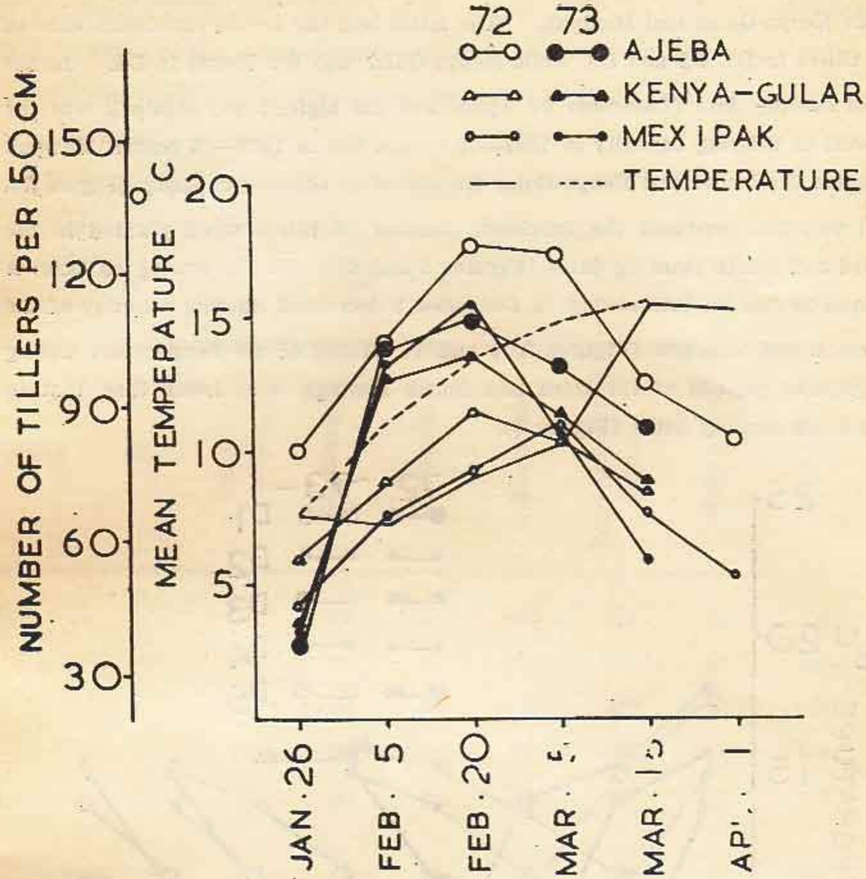


Figure 7. Number of tillers per 50 cm length during vegetative period for the three wheat varieties planted in the fifth seeding date in 1971—72 and 1972—73 seasons.

the highest maximum number of tillers in D1, D2, D3 and D4 in comparison to both Kenya-Gular and Mexipak. The latter had the lowest maximum number of tillers in D1, D2 and D3, while Kenya-Gular was the lowest in D4. In the fifth seeding date (December 9) Ajeba was the highest and Mexipak was the lowest in tillering capacity in 1971—72 season but in 1972—73 season Mexipak became the leader and Kenya-Gular the lowest in tillering capacity (Figure 7). All varieties produced the maximum number of tillers when planted in the third and fourth planting dates (Figures 5 and 6). Earlier sowing on October 14 and 28 and the late sowing on December 9 decreased tillering capacity of the three wheat varieties (Figures 3, 4 and 7). Means of air temperature during vegetative periods of the third and fourth sowings were lower than that in the other seeding dates (Figure 8).

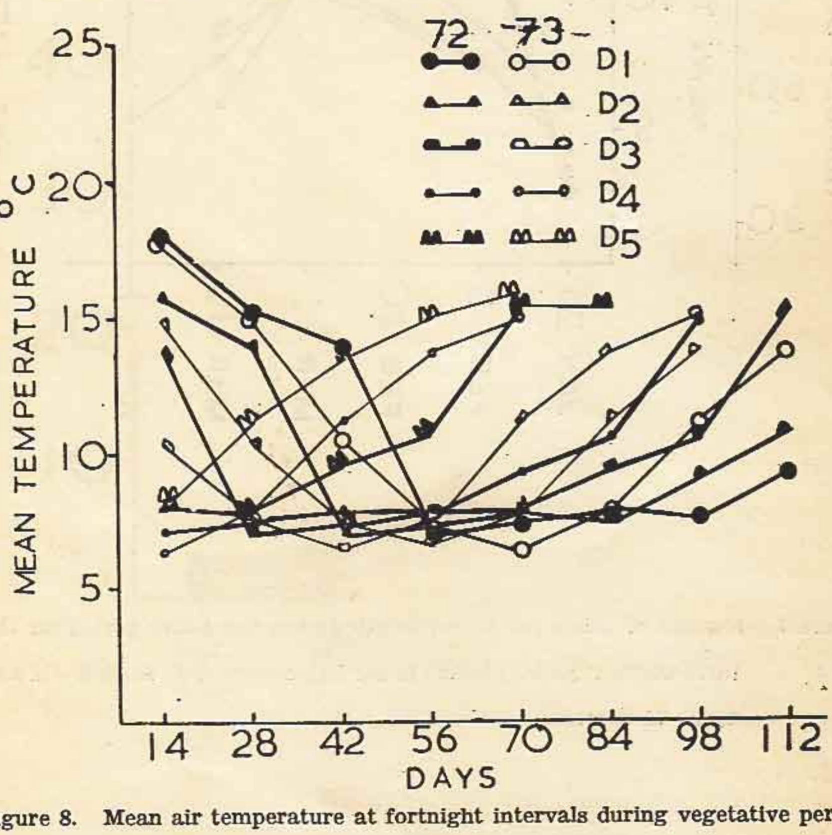


Figure 8. Mean air temperature at fortnight intervals during vegetative period in different seeding dates in 1971—72 and 1972—73 seasons.

The three wheat varieties took more time to reach the maximum number of tillers when planted in the second, third and the fourth seeding dates (Table 7). The vegetative period for Kenya-Gular and Mexipak tended to be longer

**Table 7.** Number of days for germination, tillering, elongation and maturation periods for the three wheat varieties planted in different seeding dates (Average of 1971—72 and 1972—73 seasons).

| Variety | Date of sowing | Germination | Tillering | Elongation | Total vegetative period | Maturation | Total days |
|---|---|---|---|---|---|---|---|
| Ajeba | $D_1$ | 16 | 29 | 92 | 137 | 59 | 196 |
| | $D_3$ | 16 | 49 | 66 | 131 | 52 | 183 |
| | $D_3$ | 22 | 52 | 53 | 127 | 44 | 171 |
| | $D_4$ | 27 | 41 | 51 | 119 | 41 | 160 |
| | $D_5$ | 40 | 33 | 41 | 114 | 37 | 151 |
| Kenya-Gular | $D_1$ | 16 | 21 | 76 | 113 | 76 | 189 |
| | $D_3$ | 17 | 44 | 65 | 126 | 52 | 178 |
| | $D_3$ | 23 | 51 | 52 | 126 | 41 | 167 |
| | $D_4$ | 27 | 41 | 50 | 118 | 37 | 155 |
| | $D_5$ | 38 | 35 | 38 | 111 | 35 | 146 |
| Mexipak | $D_1$ | 16 | 21 | 77 | 114 | 82 | 196 |
| | $D_2$ | 17 | 44 | 69 | 130 | 53 | 183 |
| | $D_3$ | 23 | 58 | 49 | 130 | 41 | 171 |
| | $D_4$ | 27 | 41 | 52 | 120 | 41 | 161 |
| | $D_5$ | 38 | 42 | 35 | 115 | 36 | 151 |

when planted in the second and third seedings, while for Ajeba, vegetative period became shorter with delayed seeding dates.

The variations in plant height during vegetative period for the three wheat varieties planted in D1, D2, D3, D4 and D5 are presented in Figures 9, 10, 11, 12 and 13. In general, Kenya-Gular and Mexipak had higher plant height than Ajeba in the early stages of the vegetative growth, while at the end of the vegetative growth Ajeba became second to Kenya-Gular and Mexipak became the lowest. Delayed sowing to the fifth date stimulated the rank growth of plant height early for the three wheat varieties (Figure 13). Whereas the rate of increase in plant height remained smaller when those varieties were planted on the earlier seeding dates.

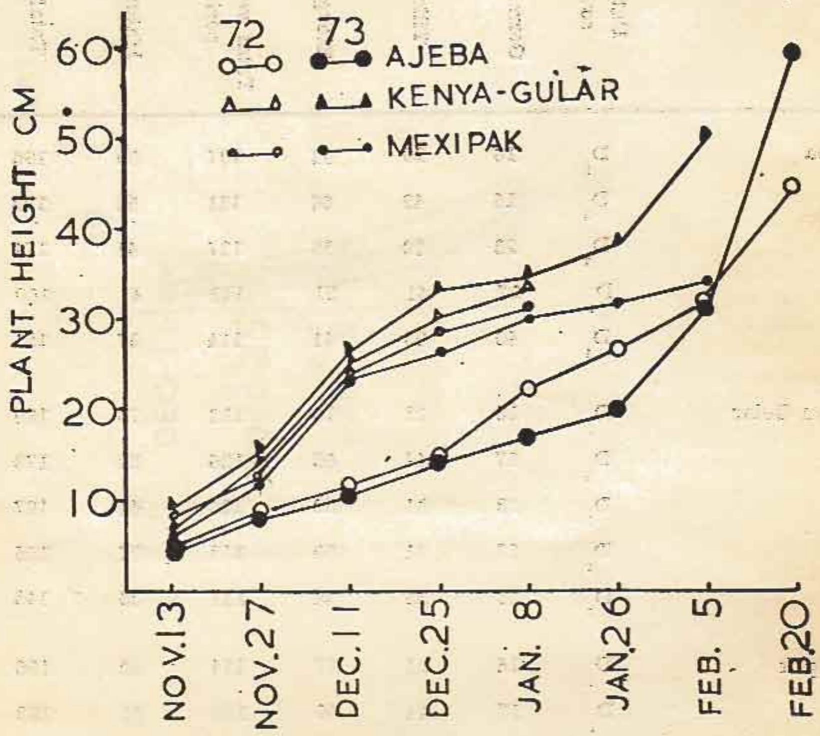


Figure 9. Plant height cm during vegetative period for the three wheat varieties planted in the first seeding date in 1971—72 and 1972—73 seasons.

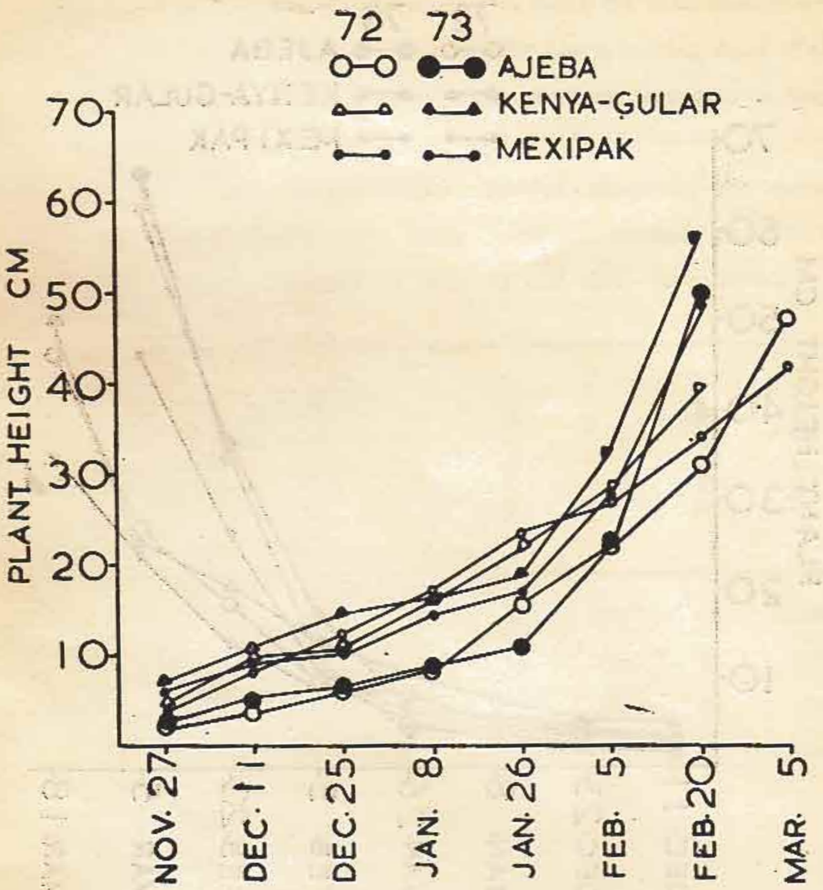


**Figure 10.** **Plant height cm during vegetative period for the three wheat varieties planted in the second seeding date in 1971—72 and 1972—73 seasons.**

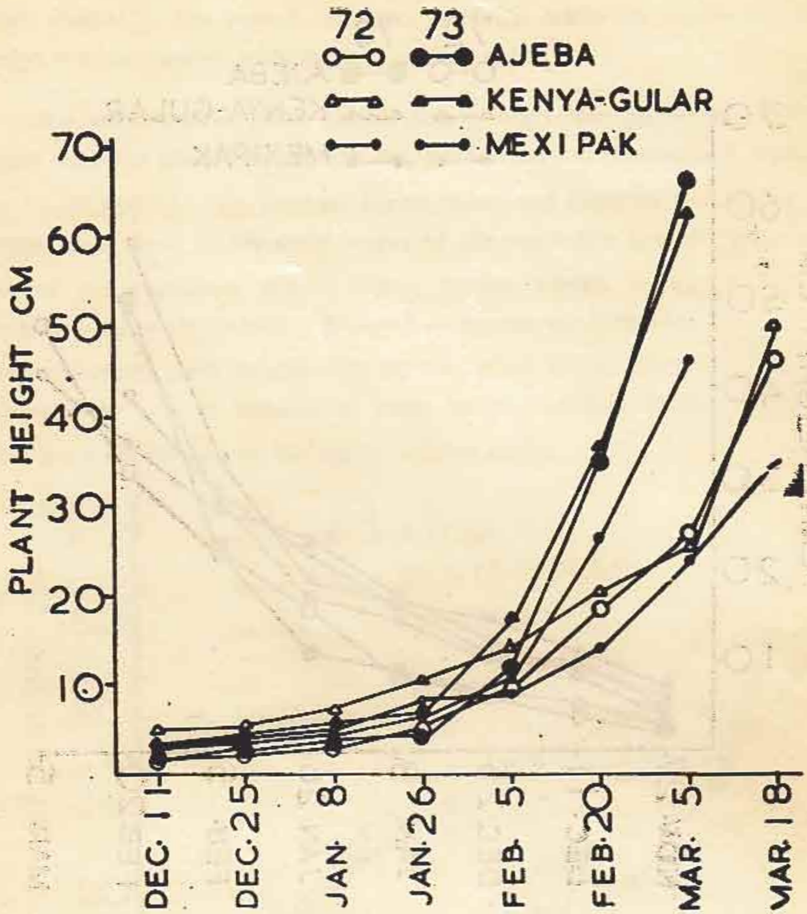


**Figure 11.** Plant height cm during vegetative period for the three wheat varieties planted in the third seeding date in 1971—72 and 1972—73 seasons.

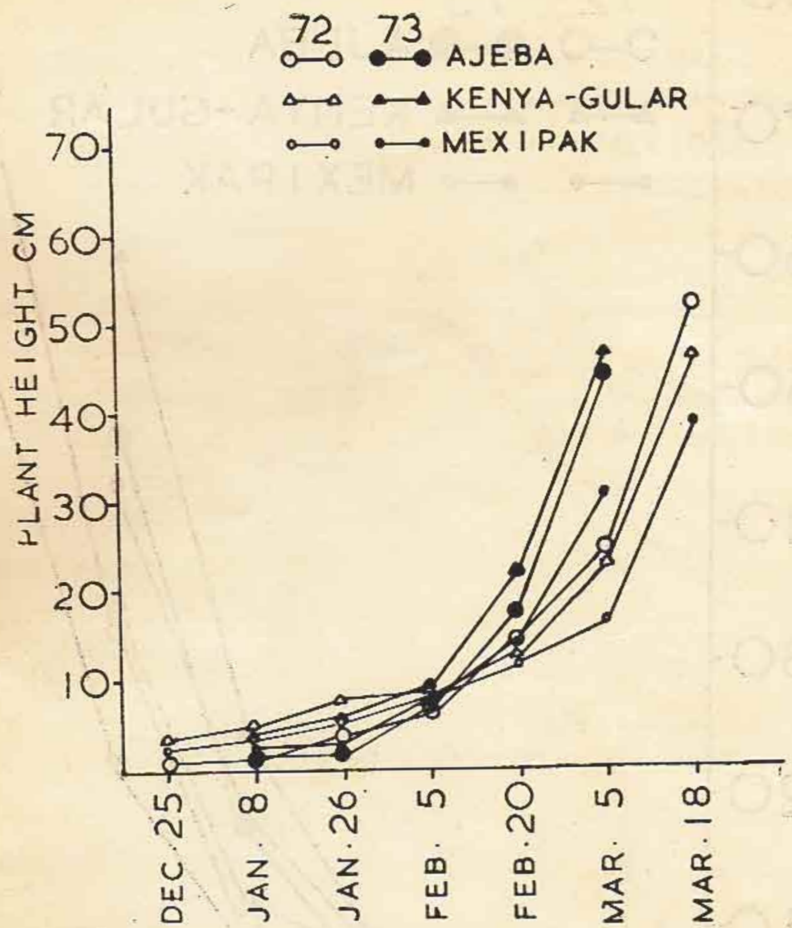


**Figure 12.** **Plant height cm during vegetative period for the three wheat varieties planted in the fourth seeding date in 1971—72 and 1972—73 seasons.**

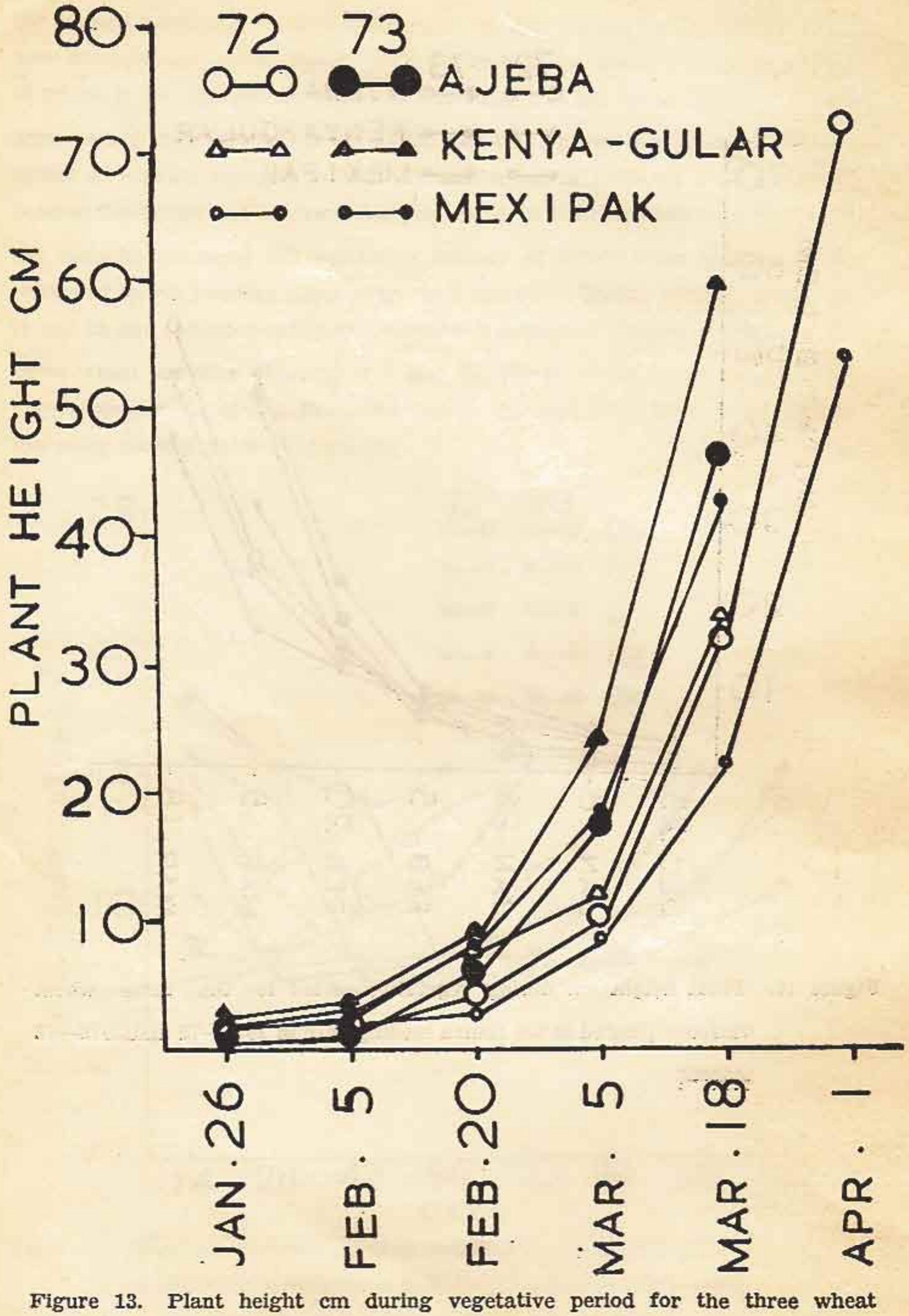


Figure 13. Plant height cm during vegetative period for the three wheat varieties planted in the fifth seeding date in 1971—72 and 1972—73 seasons.

*Percentage of fertile tillers*

Percentage of fertile tillers for the three wheat varieties planted in different seeding dates are represented in Figure 14. It is obvious from this figure that the percentage of fertile tillers for Kenya-Gular and Mexipak was reduced when these varieties planted early on October 14. Ajeba, Kenya-Gular and Mexipak had the highest percentage of fertile tillers at the third and fourth seeding dates during 1971—72 season, while in 1972—73 season the three wheat varieties had the highest percentage of fertile tillers at the fifth seeding date.

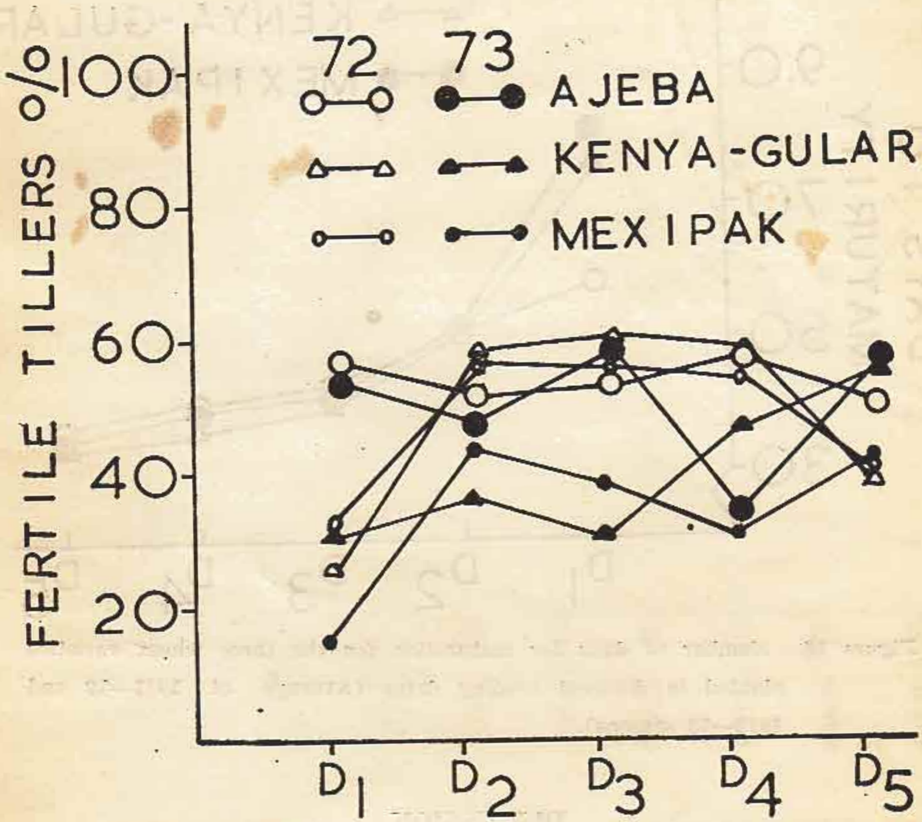


Figure 14. Percentage of fertile tillers for the three wheat varieties planted in different seeding dates in 1971—72 and 1972—73 seasons.

*Number of days to maturity*

The average number of days required to maturity for the three wheat varieties planted in different seeding dates are presented in Figure 15. Delay in seeding date to December 9 reduced the number of days required to maturity for the three wheat varieties. Kenya-Gular was the earliest variety in comparison to both Ajeba and Mexipak.

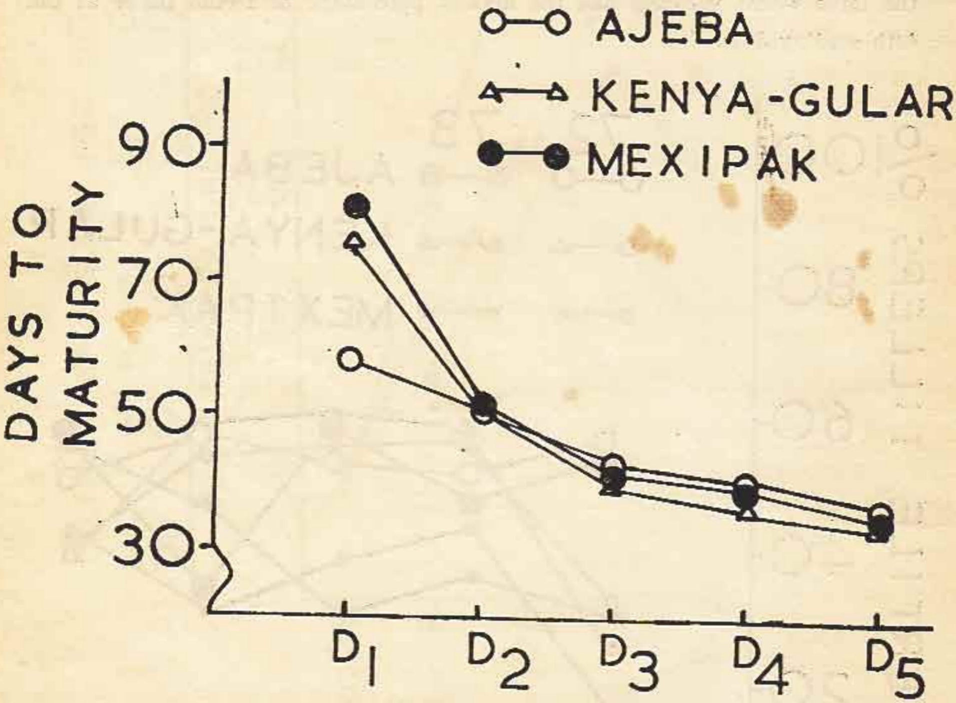


**Figure 15.** Number of days for maturation for the three wheat varieties planted in different seeding dates (Average of 1971—72 and 1972—73 seasons).

## DISCUSSION

Wheat varieties varied in their response with the variation in seeding dates applied, which differed mainly in temperature regime during

germination, vegetative and maturation periods. Thus the variations in the characteristics studied may be due to both genetical and climatic factors particularly temperature.

Kenya-Gular showed greater germination than Ajeba and Maxipak. This could be attributed to the genetic constitution and the adaptability of Kenya-Gular to the variation in climatic conditions during germination period. The three wheat varieties had lower germination percentages in the late sowing in December 9. The mean air temperature during germination period of the fifth seeding date was 7.49 °C in 1971—72 and 7.79°C in 1972—73 which is lower than that in the other seeding dates (Figure 2) and fell far below the optimum temperature which is 20—22°C (Percival, 1921).

Ajeba wheat produced the highest number of tillers; it gave 10.45 and 39.77% more tillers than Kenya-Gular and Mexipak respectively. This may be due to the fact that Ajeba is a semi-winter wheat whereas both Kenya-Gular and Mexipak are spring wheats. Watson *et al.* (1963) mentioned that winter varieties have more tillers than spring varieties. Each wheat variety reached a maximum number of tillers then decreased gradually to a certain number at heading time, where some of these tillers died. Watson *et al.* (1963) indicated that this decrease in number of tillers comes to a constant values after ear emergence.

The three wheat varieties reached the highest number of tillers when planted in the third and fourth seedings. In these dates, mean temperature during the beginning of the vegetative period which extended from 7.54—13.75°C in 1971—72 and 7.90—10.25°C in 1972—73 for D3 and from 6.83—7.54°C in 1971—72 and 6.48—11.01°C in 1972—73 for D4, was lower than that of the other dates which is extended from 7.54—18.04°C in 1971—72 and 7.60—17.69°C in 1972—73 (Figure 8). This lower temperature seems to be more favorable for tiller production especially for Ajeba wheat. The lower mean temperature during 1972—73 season may clear this point out. In Italy, Toniolo as quoted by Whyte (1960) stated that tillering was much lower in a year when January/February temperatures were very low in 1952/53 than when they were higher in 1953/54.

On the average earlier seeding dates on October 14 and 28 reduced the number of tillers for Ajeba but increased tiller number of Kenya-Gular and Mexipak. Schlehuber and Tucker (1967), Beech and Norman (1966) mentioned that earlier sowing decreases number of tillers, while Woodward (1956) and Choudhry and Khalid (1963) found that later sowing decreases tiller number.

Plant height was affected to a rather large extent by the variations in mean temperature in different seeding dates applied. Ajeba and Kenya-Gular had higher plant height at the end of the vegetative and at maturity periods than Mexipak. This may be due to the fact that Mexipak is a semi-dwarf variety whereas both Kenya-Gular and Ajeba are tall varieties. On the average early sowing on October 14 and the late one at December 9 reduced the plant height at maturity for the three verieties except in the third sowing where there was more reduction in plant height. These results agreed in some respect to those obtained by Suput (1966) and Ito and Soga (1968).

Early sowing on October 14 reduced the percentage of fertile tillers for the three varieties. These results varied from those obtained by Choudhry and Khalid (1963).

Number of days to maturity was reduuced as seeding date was delayed from the first to the fifth sowing dates. Similarly. Florell (1929) indicated that the time to maturity had the tendency to converge when wheat varieties were sown in different dates.

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# EFFECT OF SEEDING DATES ON THREE WHEAT VARIETIES IN THE MIDDLE IRRIGATED REGION OF IRAQ. II. YIELD COMPONENTS, GRAIN YIELD PROTEIN PERCENTAGE AND YIELD*

**ADNAN HASSAN ADARY AND W.S. EL-SHAMMA**

Department of Plant Production, College of Agriculture,

University of Baghdad, Abu Ghraib

(Revised 12 June 1974)

## SUMMARY

In a split plot experiment three wheat varieties, Ajeba 210, Kenya-Gular and Maxipak were planted in 5 seeding dates, October 14,28 and November 11, 25 and December 9 during 1971—72 and 1972—73 seasons. The following results were obtained:

Ajeba 210 was the highest in number of heads per 50 cm length and grain yield, while Kenya-Gular was the highest in protein content of the grain. Mexipak was significantly the leading in number of seeds per head. Both Kenya-Gular and Ajeba 210 were the heaviest in 1000 seeds weight.

Sowing the three wheat varieties in November 25 gave the highest number of heads per unit area, grain yield and protein yield. Too early sowing in

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October 14 reduced number of heads per unit area and grain yield especially in Kenya-Gular and Mexipak wheats.

Later sowing in December 9 reduced the weight per 1000 seeds and increased protein content of the grain for the three wheat varieties.

Protein content of the grain for wheat varieties was positively correlated with the main daily air temperature during maturation periods.

The increase in grain yield was correlated with the increase in each of the yield components.

Number of heads per unit area, weight per 1000 seeds, grain yield, protein content of the grain varied significantly according to the variation in years.

From this study it is suggested that sowing in November 25 to be the most suitable date for Kenya-Gular and Mexipak wheats because it gave the highest yield of grain and protein.

## الخلاصــــة

في تجربة الواح منشقة زرعت ثلاثة اصناف من الحنطة وهي : العجيبة ٢١٠ ، كيناكولار والمكسيباك في خمسة مواعيد زراعة في ١٤ و ٢٨ تشرين اول و ١١ ، ٢٥ تشرين ثاني و ٩ كانون اول خلال موســـمي ٧١ــ٧٢ و ٧٢ــ٧٣ ٠

وقد حصل على النتائج التالية :ــ

كانت العجيبة ٢١٠ الاعلى بعدد السنابل لمسافة ٥٠ سم وحاصل الحبوب بينما كانت الكيناكولار الاعلى في المحتوى البروتيني للحبوب ٠ تفوقت المكسيباك احصائيا في عدد البذور للسنبلة ٠ كانت كلا من كيناكولار والعجيبة ٢١٠ أثقل في وزن ١٠٠٠ حبة ٠

ادت زراعة الاصناف الثلاثة في ٢٥ تشرين الثاني الى اعطاء اعلى عدد للسنابل في وحدة المساحة ، حاصل الحبوب وحاصل البروتين ٠ وان الزراعة المبكرة في ١٤ تشرين اول ادت الى انخفاض عدد السنابل في وحدة المساحة وحاصل الحبوب وبصورة خاصة في الحنطة كيناكولار والمكسيباك ٠

أدت الزراعة المتأخرة في ٩ كانون اول الى انخفاض وزن ١٠٠٠ حبة وزيادة المحتوى البروتيني للاصناف الثلاثة .

إرتبط المحتوى البروتيني للحبوب ارتباطا موجبا بمعدل درجة حرارة الهواء اليومية خلال فترة النضج .

ان الزيادة في حاصل الحبوب ارتبطت بالزيادة في كل من مكونات الحاصل . يتغاير عدد السنابل في وحدة المساحة ، وزن ١٠٠٠ بذرة ، حاصل الحبوب ، المحتوى البروتيني للحبوب ، احصائيا بتغير السنين .

يقترح من هذه الدراسة في ان الزراعة في ٢٥ تشرين ثاني مناسبة لزراعة كل من الكيناكولار والمكسيباك لانها اعطت اعلى حاصل للحبوب والبروتين .

## INTRODUCTION

The optimum seeding date for Ajeba 210 (local) is in mid November (El-Shamma, 1967). Two new wheat varieties, Kenya-Gular and Mexipak were released for a large scale production in the middle and southern regions of Iraq. No information is available regarding the response of these new varieties when planted in different seeding dates. So it was designed to obtain information regarding yield, yield components, protein content of the grain and protein yield in addition to the relationship between protein content of the grain and mean air temperature during maturation for the new varieties and the local variety Ajeba 210.

Sowing dates influences number of heads per plant more than the number of seeds per head and weight per 1000 seeds (El-Shamma, 1964). Tesic (1967) indicated that late sowing decreased the number of heads per unit area and grain per head. Asana and Williams (1965) and Beech and Norman (1966) pointed out that weight per 1000 seeds and grain yield were reduced by the late sowing. They indicated that this decrease in weight per 1000 seeds and grain yield in late sowing may be due to the rising in temperature during maturation period. But Pal *et al.* (1959) reported that early maturing wheat variety NP 792 gave the highest yields when sown late in November.

Florell (1929) and Vez (1971) reported that the protein content of the grain was increased in late seeding dates, while *Wallin* (1965) indicated that delay in sowing date reduced grain protein content. According to Finney and Fryer (1958) high temperature during the ripening period is harmful to wheat quality, where loaf volume and mixing time decreased in general with the increasing accumulated temperature above 90°F during the last 15 days of fruiting period. Simka and Greb (1973) reported that the maximum air temperature had the greatest effect on grain protein during the 5-days period, 15 to 20 days before maturity.

## MATERIALS AND METHODS

This research was conducted at the College of Agriculture irrigated farm, Abu-Guraib, University of Baghdad during 1971—72 and 1972—73 seasons, and as described in Part I of this series. Designations and dates of seeding for both seasons were as follows:

| | |
|---|---|
| D1 | October 14 |
| D2 | October 28 |
| D3 | November 11 |
| D4 | November 25 |
| D5 | December 9 |

Yield components namely, number of heads per 50 cm length, number of seeds per head and weight per 1000 seeds(g) were taken from a 50 cm part of the row selected randomly from the middle four rows in each plot as explained by LeClerg *et al.* (1962). Grain yield was taken by harvesting the middle four rows by hand then threshed and cleaned and weighed in grams and converted to kg/ha unit.

Crude protein content of the grain on wet basis was determined in duplicate samples using UDY method as described by Udy (1971). Protein yield (kg/ha) was calculated by multiplying grain yield (kg/ha) by the protein percentage of the grain. Data regarding daily air temperature was obtained from weather

station records in Baghdad. Data collected on yield components grain yield, protein percentage and protein yield were analyzed statistically as indicated by LeClerg *et al.* (1962), using IBM computer-subroutine in the computer Center of the College of Engineering, University of Baghdad.

## RESULTS AND DISCUSSION

Data in Table 1 shows the number of heads per 50 cm length, number of seeds per head, weight per 1000 seeds, grain yield, percent protein content of the grain and protein yield for Ajeba 210, Kenya-Gular and Mexipak wheats. The three wheat varieties differed significantly in yield components, grain yield and percent protein content of the grain. The difference in protein yield was not significant (Table 1). Ajeba 210 was significantly the highest in number of heads per 50 cm length and grain yield whereas both Ajeba 210 and

Table 1. Number of heads per 50 cm length, number of seeds per head, weight per 1000 seeds, grain yield kg/ha, percent protein content of the grain (on wet basis) and protein yield kg/ha for the three wheat varieties. (Average of 1971—72 and 1972—73 seasons).

| | Varieties | | | L.S.D. | |
|---|---|---|---|---|---|
| Plant character | Ajeba 210 | Kenya-Gular | Mexipak | 5% | 1% |
| Number of heads per 50 cm length | 61.10** | 47.65 | 36.73 | 4.95 | 6.43 |
| Number of seeds per head | 18.32 | 18.51 | 30.05** | 1.94 | 2.53 |
| Weight per 1000 seeds (g) | 38.85** | 38.90** | 34.69 | 0.56 | 0.75 |
| Grain yield kg/ha | 2410.17** | 2104.07 | 2159.35 | 218.02 | 298.55 |
| Percent protein content of the grain | 9.05 | 10.28** | 9.04 | 0.26 | 0.35 |
| Protein yield kg/ha | 217.57 | 215.72 | 194.64 | N.S | N.S |

** $P < 0.01$

N.S. Not significant.

Kenya-Gular were heavier in weight per 1000 seeds than Mexipak. Mexipak was the leading in number of seeds per head and Kenya-Gular was significantly the highest in percent protein content of the grain. However, it should be mentioned that the mean monthly temperature during experimentation period was lower than the average temperature in the past 30 years (Figure 1). According to El-Shamma and Zubaidi (1968) that in the

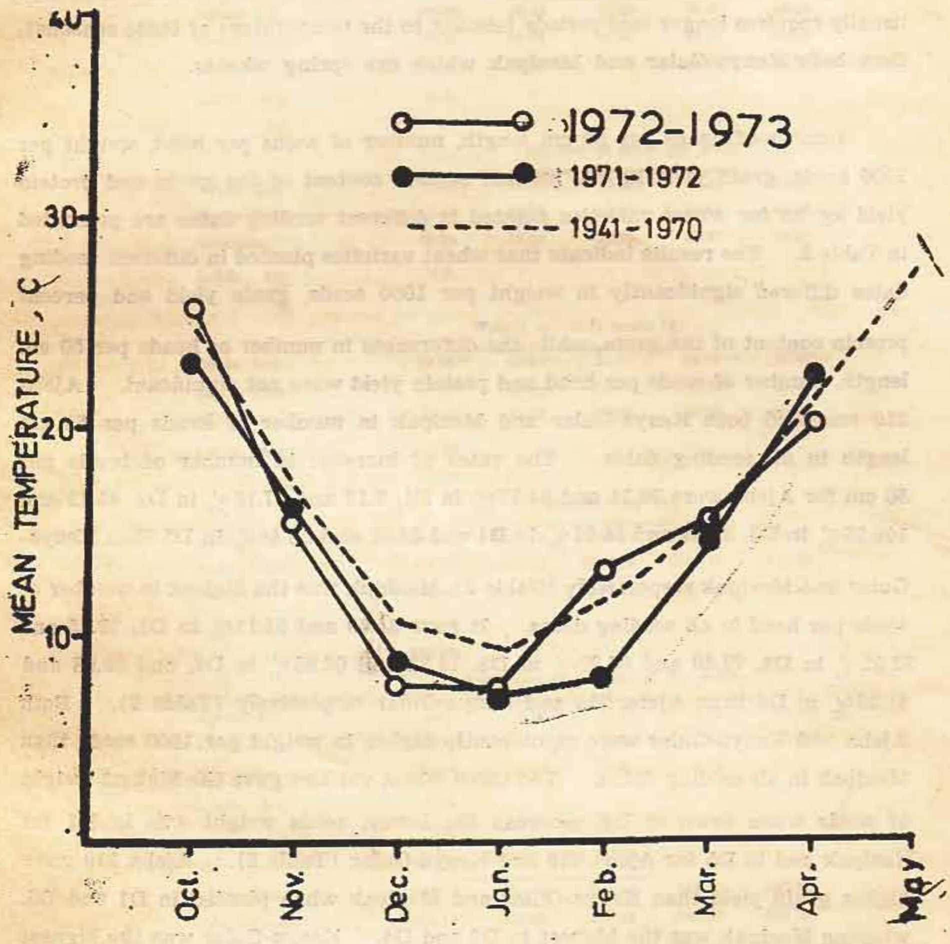


Figure 1. Mean temperature °C during experimentation period in 1971—72 and 1972—73 seasons in comparison to the mean monthly temperature during the same period in the past 30 years in Baghdad area.

normal years, spring wheat varieties in the central irrigated region of Iraq exceeds semi-winter and winter varieties in grain yield, but in cold years, semi-winter wheat varieties exceed spring varieties. Watson *et al.* (1963) stated that under suitable conditions winter wheats were 3-15% greater than spring wheat. Accordingly the increase in number of heads per 50 cm length and grain yield of Ajeba over both Kenya-Gular and Mexipak during the seasons of this work may be attributed to the fact that Ajeba is a semi-winter wheat and usually requires longer cold periods (similar to the temperature of these seasons), than both Kenya-Gular and Mexipak which are spring wheats.

Number of heads per 50 cm length, number of seeds per head, weight per 1000 seeds, grain yield kg/ha, percent protein content of the grain and protein yield kg/ha for wheat varieties planted in different seeding dates are presented in Table 2. The results indicate that wheat varieties planted in different seeding dates differed significantly in weight per 1000 seeds, grain yield and percent protein content of the grain, while the differences in number of heads per 50 cm length, number of seeds per head and protein yield were not significant. Ajeba 210 exceeded both Kenya-Gular and Mexipak in number of heads per 50 cm length in all seeding dates. The rates of increase in number of heads per 50 cm for Ajeba were 26.11 and 94.17% in D1, 9.17 and 37.16% in D2, 45.43 and 106.25% in D3, 30.84 and 58.01% in D4 and 28.61 and 56.46% in D5 than Kenya-Gular and Mexipak respectively (Table 2). Mexipak was the highest in number of seeds per head in all seeding dates. It gave 34.09 and 54.11% in D1, 79.55 and 82.93% in D2. 73.60 and 66.89% in D3, 74.33 and 68.88% in D4, and 59.98 and 41.36% in D5 than Ajeba 210 and Kenya-Gular respectively (Table 2). Both Ajeba and Kenya-Gular were significantly higher in weight per 1000 seeds than Mexipak in all seeding dates. The three wheat varities gave the highest weight of seeds when sown in D2, whereas the lowest seeds weight was in D1 for Mexipak and in D5 for Ajeba 210 and Kenya-Gular (Table 2). Ajeba 210 gave higher grain yield than Kenya-Gular and Mexipak when planted in D1 and D3, whereas Mexipak was the highest in D2 and D4. Kenya-Gular was the highest in D5. Sowing the three varieties in the 4th seeding date in November 25 resulted in the highest grain yield in comparison to sowing these varieties in the other seeding dates (Table 2). Earlier sowing in October 14 or later sowing in December 9 reduced the grain yield of the three wheat varieties used.

**Table 2.** Yield components, grain yield kg/ha, percent protein content of the grain (on wet basis) and protein yield kg/ha for wheat varieties planted in 5 seeding dates (Average of 1971—72 and 1972—73 seasons).

| | Date of Seeding | | | | |
|---|---|---|---|---|---|
| **Varieties** | **D1** | **D2** | **D3** | **D4** | **D5** |
| | Number of heads per 50 cm length | | | | |
| Ajeva 210 | 50.00 | 52.13 | 66.00 | 70.50 | 66.88 |
| Genya-Gular | 39.25 | 57.75 | 45.38 | 53.88 | 52.00 |
| Mexipak | 25.75 | 37.88 | 32.00 | 45.25 | 42.75 |
| L.S.D. 5% | N.S. | | | | |
| 1% | | | | | |
| | Number of seeds per head | | | | |
| Ajeba 210 | 18.86 | 18.39 | 17.16 | 18.51 | 18.67 |
| Kenya-Gular | 16.41 | 18.05 | 17.85 | 19.11 | 21.13 |
| Mexipak | 25.29 | 33.02 | 29.79 | 32.27 | 29.87 |
| L.S.D. 5% | N.S. | | | | |
| 1% | | | | | |
| | Weight pe: 1000 seeds (g) | | | | |
| Ajeba 210 | 39.83** | 40.07** | 30.13** | 38.18** | 37.03** |
| Kenya-Gular | 37.61** | 42.01** | 39.43** | 38.68* | 36.69* |
| Mexipak | 32.45 | 35.98 | 35.05 | 35.90 | 34.09 |
| L.S.D. 5% | 1.86 | | | | |
| 1% | 2.48 | | | | |
| | Grain yield kg/ha | | | | |
| Ajeba 210 | 2362.21** | 2463.98 | 2540.44 | 2892.63 | 1791.62 |
| Kenya-Gular | 1495.09 | 2421.23 | 2210.15 | 2545.70 | 1848.16 |
| Mexipak | 1315.45 | 2804.33 | 2051.31 | 2971.40 | 1654.26 |
| L.S.D. 5% | 679.15 | | | | |
| 1% | 838.52 | | | | |
| | Percent protein content of the grain | | | | |
| Ajeba 210 | 8.27 | 8.20 | 8.94 | 9.49 | 10.36 |
| Kenya-Gular | 10.63** | 9.71** | 9.70* | 10.41** | 10.95* |
| Mexipak | 8.16 | 8.49 | 8.81 | 9.24 | 10.19 |
| L.S.D. 5% | 0.64 | | | | |
| 1% | 0.85 | | | | |
| | Protein yield kg/ha | | | | |
| Ajeba 210 | 193.30 | 202.05 | 227.54 | 276.32 | 188.65 |
| Kenya-Gular | 155.18 | 234.03 | 217.93 | 267.93 | 203.72 |
| Mexipak | 110.92 | 239.25 | 178.69 | 276.59 | 167.76 |
| L.S.D. 5% | N.S. | | | | |
| 1% | | | | | |

* $P < 0.05$

** $P < 0.01$

N.S. = Not significant

Kenya-Gular was significantly the highest in protein content of the grain in all seeding dates (Table 2). It exceeded both Ajeba and Mexipak by 28.53 and 25.65% in D1, 18.41 and 14.37% in D2, 8.50 and 10.10% in D3, 9.69 and 12.66% in D4 and 5.69 and 7.45% in D5, respectively. The three wheat varieties gave the highest protein content of the grain when planted in the latest seeding date in December 9. This increase in protein content of the grain could be attributed to the higher mean daily air temperature (which extended from 14.49°C in D1 to 23.15°C in D5 during 1971—72 and from 17.12°C in D1 to 21.68°C in D5 during 1972—73) during maturation periods of the three wheat varieties planted in December 9 (Figure 2). The highly significant positive simple correlation coefficients (except for Kenya-Gular in 1971—72) between mean daily air temperature during maturation periods and protein content of the grain may clear this point especially in Ajeba 210 and Mexipak wheats. This finding is in agreement with that obtained by Seitov (1971) and Florell (1929) where they indicated that delay in sowing date increase protein content of the grain and the early sown wheats were starchy and low in protein content.

Ajeba 210 gave higher protein yield in D1 and D3 than Kenya-Gular and Mexipak, whereas Mexipak was the highest in D2 and D4, Kenya-Gular was the highest in D5. The three wheat varieties gave the highest protein yield when sown in the 4th planting in November 25. These results showed clearly that the 4th seeding date in November 25 is the most suitable for planting the three wheat varieties to obtain the highest yield of protein and grain.

Number of heads per 50 cm, weight per 1000 seeds, grain yield and protein content of the grain varied significantly according to the variation in years. Also weight per 1000 seeds for varieties, and number of heads per 50 cm for varieties planted in different seeding dates responded differently in different years (Table 3). Harrington (1946) showed that the variety X date interaction being highly significant in each of several years, also El-Shamma (1967) indicated that years, dates and dates X years were highly significant where dates responded differently in different years.

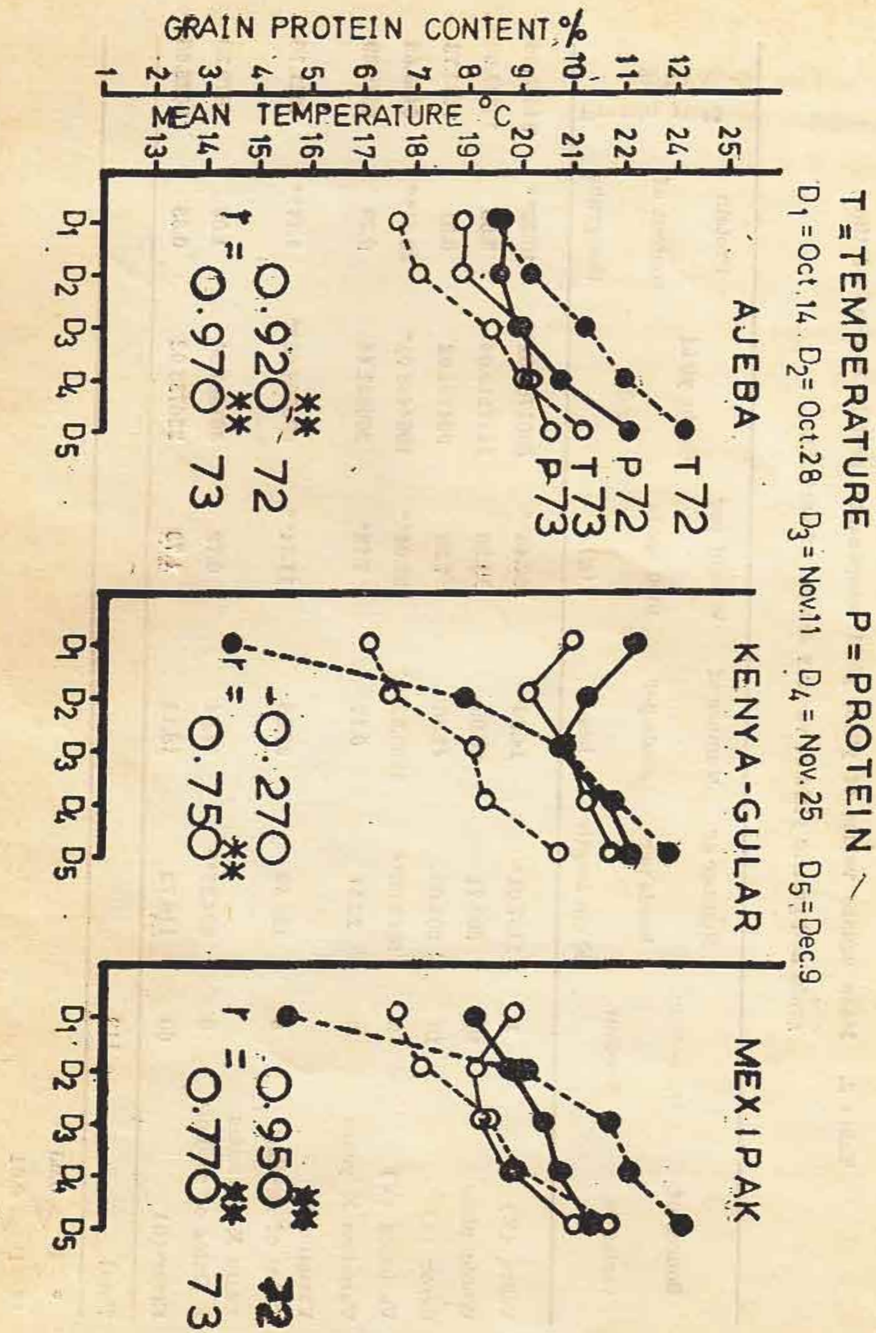


Figure 2. Protein percentage (on wet basis) for the three wheat varieties planted in different seeding dates in relation to the mean temperature °C during maturation period in 1971—72 and 1972—73 seasons.

Table 3. Mean square values of yield, yield components, protein co
grain and protein yield of various sources of variation.

| Source of variation | Degrees of freedom | Number of heads per 50 cm length | Number of seeds per head | Weight per 1000 seeds (g) | Grain yield kg/ha |
|---|---|---|---|---|---|
| Years (Y) | 1 | 1197.01* | 14.38 | 132.45** | 8001763.01* |
| Whole plots | 19 | 399.71 | 20.99 | 13.26 | 1417110.04 |
| Error (a) | 19 | 204.69 | 41.86 | 7.25 | 904794.92 |
| Varieties (V) | 2 | 5962.66** | 1805.52** | 232.94** | 1064488.01* |
| Varieties X years | 2 | 22.51 | 0.17 | 7.13* | 266821.44 |
| Varieties X Dates of seeding | 8 | 123.69 | 27.96 | 11.34** | 695658.62* |
| Years X Varieties X Dates of seeding | 8 | 384.27** | 37.54 | 0.72 | 361397.56 |
| Error (b) | 60 | 116.72 | 18.13 | 1.73 | 236735.02 |
| Total | 119 | | | | |

* $P < 0.05$
** $P < 0.01$

between yield and size of kernels. Quisenberry (1928) concluded that under field conditions number of heads per unit area was one of the most importent factors in determining yield. Grain yield had the highest correlation coefficient with the number of heads per 50 cm length (Table 4).

Table 4. Simple correlation coefficient values between grain yield and each of yield components and protein content of the grain, and between content of the grain and each of yield camponents. (Average of of 1971—72 and 1972—73 seasons).

| Plant characters | r |
|---|---|
| Grain yield and number of heads per 50 cm length | 0.404** |
| Grain yield and number of seeds per head | 0.230** |
| Grain yield and weight per 1000 seeds | 0.457** |
| Grain yield and protein content of the grain | − 0.128 |
| Protein content of the grain and number of heads per 50 cm length | 0.108 |
| Protein content of the grain and number of seeds per head | − 0.151 |
| Protein content of the grain and weight per 1000 seeds | − 0.003 |

** $P < 0.01$

Grain yield was negatively but not significantly correlated with the protein content of the grain (Table (4). Protein content of the grain was positively and not significantly correlated with the number of heads per 50 cm length ($r = 0.108$), while the correlations were negative and not significant with the number of seeds per head and weight per 1000 seeds. These results indicate that the increase in protein content of the grain may be accompanied by a decrease in grain yield, number of seeds per head and weight per 1000 seeds.

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*Iraqi J. agric. Sci.*, Vol. IX, 1974.

# SCANNING ELECTRON MICROSCOPY AND SIALIC ACID CONTENT OF COW AND BUFFALO MICELLAR CASEIN

By

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(*Revised MS received, May* 1974)

## SUMMARY

**Electron microscopy showed that buffalo micellar casein solution contained larger particles than that of the cow. Rennin coagulation of buffalo milk was much faster than that of cow's milk. Initiation of increase in particle size during coagulation appeared during the first five minutes after the addition of rennet. Clotting was uniform and compact after 20 min of rennin action. This may be attributed to the aggregation of *as*—and *B*—casein units linked by Ca++ and the specific physico-chemical functions of the phosphate groups of the B-casein.**

**Buffalo micellar casein contained less sialic acid than cow's casein. Release of sialic acid was a continuous process during coagulation and most of the acid was released during 20 min after the addition of rennin. Improvement in the qualities of hard cheese made from buffalo milk may be achieved by creating a ratio of *a*—to *B*—casein, close to 3 : 1 as it is in ewes' milk.**

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## الخلاصـــة

لقد استعمل المايكروسكوب الالكتروني في دراسة التغيرات التى تطرأ عـلى حليب الابقار وحليب الجاموس ووجد بان جزيئات الكازين في حليب الجاموس هى اكبر منها في حليب الابقار • كما وجد ان مفعول الرنين في تجبن الحليب هو اسرع في حليب الجاموس عنها في حليب الابقار • لقد وجد ان ابتداء عملية التجبـن نتيجة لاضافة الرنين يبدأ بعد خمسة دقائق من آضافة الرنين وان عملية التجبن قد تكاملت بعد مرور عشرين دقيقة • يمكن تعليل تكامل عملية التجبن قد تكاملت بعد مرور عشرين دقيقة • يمكن تعليل تكامل عملية التجبن بتجمع جزيئات (الفا) كازين و (بيتا) كازين نتيجة لعمل الكالسيوم ونتيجة لمفعول بعض الخواص الحيوية والكيمياوية لمجاميع الفوسفات التى هى من ضمن تركيب الـ (بيتا) كازين •

لقد وجد ان جزيئات الكازين في حليب الجاموس تحتوى على نسبة اقل من حامض السايلك عنها في حليب الإبقار وان تحرر هذا الحامض هو عملية مستمرة اثناء عملية التجبن وان اكثر كمية حررت بعد مرور عشرين دقيقة من اضافة الرنين (المنفحة) • يعتقد ان تحسين نوعية الجبن الجاف المصنـوع من حليب الجاموس قد يأتى عن طريق احداث تعادل بين (الفا) و (بيتا) كازين •


## INTRODUCTION

Considerable interest has been focussed on the properties and behavior of casein micelles during rennin coagulation. Nagasawa *et al.* (1970) believed that bovine casein micelles are composed of uniform subunit particles formed firstly by aggregation of *as*—and *B*—casein molecules. Sabarual and Ganguli (1970) reported that cow's and buffalo's casein micelles differ in their physico-chemical properties and difficulties experienced in preparing products from buffalo milk may be attributed to such differences. Monieb and El-Gazzar (1970) explained that higher levels of calcium and inorganic phosphorus found in the paracaseinate-phophate complex of buffalo's milk explain the differences in the qualities of cheese compared with that prepared from cow's milk. Sabarual and Ganguli (1970) indicated that micellar casein from buffalo milk contains less sialic acid and less *as*—casein that of cow's micellar casein. Ledford *et al.* (1968) stated that rennin degrades *as*—casein much

faster than B-casein. Wheelock and Knight (1969) reported that sialic acid attached to k-casein is not essential for the rennin action or for the stabilization of casein micelles, but it may effect the rate of rennin action. Kiermeier and Gutty (1970) explained that before the addition of rennin, the casein solution contains large numbers of particles with a small diameter. After addition of rennin, size distribution remains constant at first and changes are observed only after 2/3 of the coagulation time. Creamer and Lawrence (1970) pointed out that rennin acts on casein micelles by cleaving the k-casein into an acid soluble glycomacropeptide and a basic insoluble para-*k*-casein. The aim of this investigation was to study the coagulation of cow's and buffalo's milk electron microscopically and the sialic acid content during the rennet coagulation process.

## MATERIALS AND METHODS

### *Electron Microscopy*

Samples of cow's whole and skim milk and buffalo's whole milk* were examined. A modified procedure of Carrol *et al.* (1968) was used. 200 ml of raw milk was warmed to 32°C and 0.2 ml of liquid rennet** diluted 10 times with cold water was added. 0.2 ml samples of the warmed milk taken before the addition of rennet and at 5, 10, 20, 30 and 60 min intervals after addition were fixed with 2 ml of 1.0% glutaraldehyde for 15 min, then diluted with distilled water at the rate of 1 : 20. A small portion of the fixed sample was placed on the surface of a round metal stub 12 mm in diameter and left to dry. After drying, it was placed into an evaporator coated with carbon and gold, then examined in the electron microcope. The electron microscope used was an S4 Stereoscan Electron Microscope from Cambridge Scientific Instrument, England.

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* Buffalo's whole milk preserved was sent air mail from the College of Agriculture, Baghdad, Iraq.

** Horan Sally Co. Ltd., Rexdale, Ontario, Canada.

*Estimation of Sialic Acid*

Estimation of sialic acid was carried out according to the thio-barbituric acid assay method of Warrens (1963) as modified by Gupta and Ganguli (1965) and (1967). Chemicals used were abtained from Eastman Organic Chemical Co., Rochester, N.Y., U.S.A. Results reported are averages of two determinations.

## RESULTS AND DISCUSSION

*Electron Microscopyp*

The results obtained are shown in Figures 1, 2 and 3. These photo-micrographs show that before the addition of rennet, the casein solution contained large numbers of small diameter, particles; diameter size was larger for buffalo than for cow casein. Five minutes after the addition of rennet there was an increase in the number of large particles and a decrease in the number of small particles. This indicates an initiation of the aggregation of particles created by cleavage of *K*- casein by the rennin enzyme.

After ten mintes, the size of casein particles was further increased probably as the result of aggregation of *as*—and *B*—casein to form subunits. The aggregation of *as*—and *B*—casein may be attributed to the specific physico-chemical functions and the specialized biochemical functions of the four phosphate groups attached closely to the N-terminal of the peptide chain of the B-casein. After 20 mintes, the aggregation of casein micelles was more uniform and compact, and at this stage, calcium cross-linking may be especially important in the layer formation of *as*—and *B*—casein micelles. This needs further investigation.

*Sialic Acid Content and Release*

Sialic Acid Contents of cow's and buffalo's milk micellar casein before and after the addition of rennet are separated in Table 1. These results show that buffalo micellar casein contains less sialic acid than cow's micellar casein.

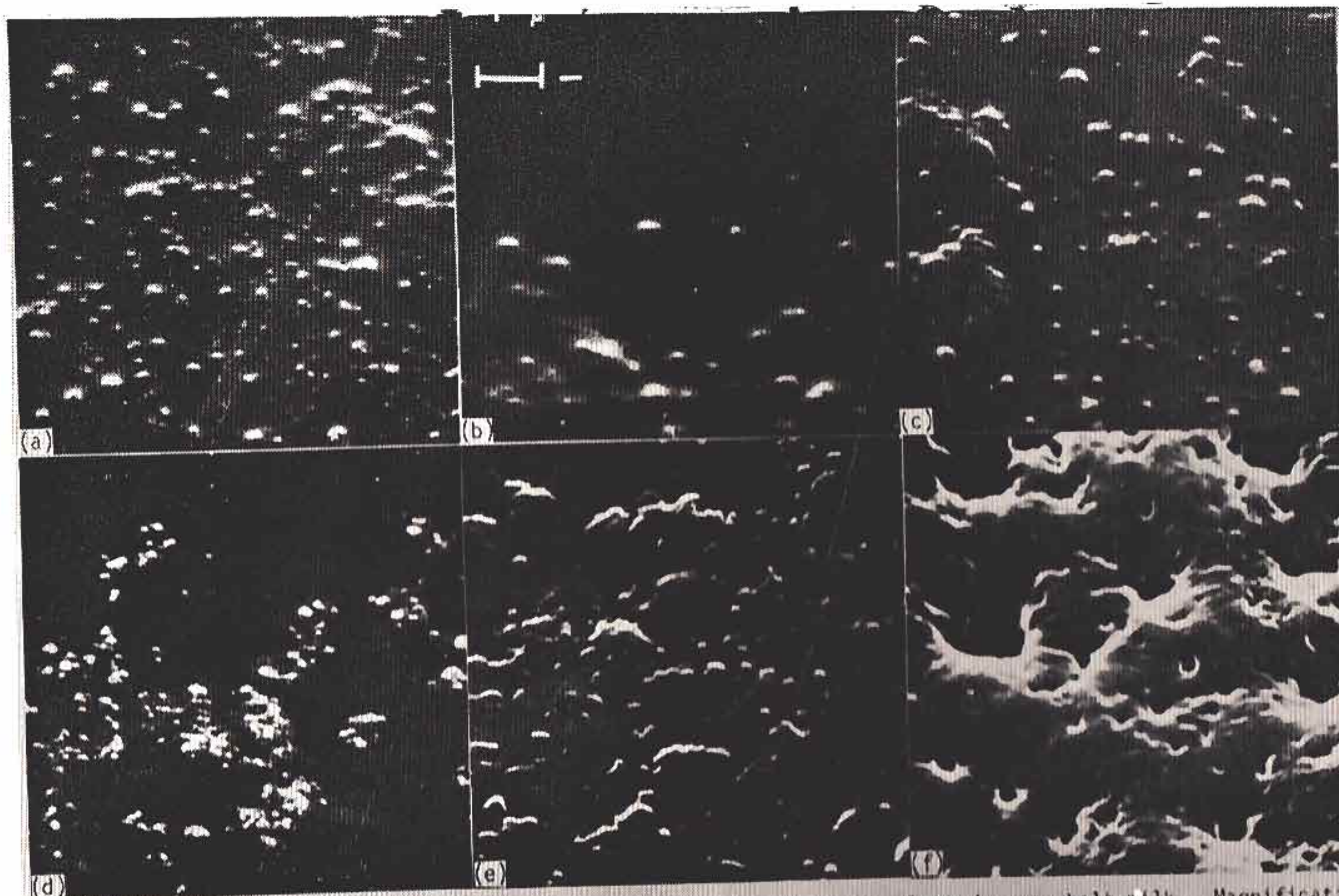


Fig. 1. Scanning electron microscope photomicrographs of Rennin clotted cows whole milk. Magnification 6000X

(a) Casein micelles in cows whole milk
(b) Casein micelles in cows whole milk with Rennin after 5 min
(c) Casein micelles in cows whole milk with Rennin after 10 min
(u) Casein micelles in cows whole milk with Rennin after 20 min
(e) Casein micelles in cows whole milk with Rennin after 30 min
(f) Casein micelles in cows whole milk with Rennin after 1 hr

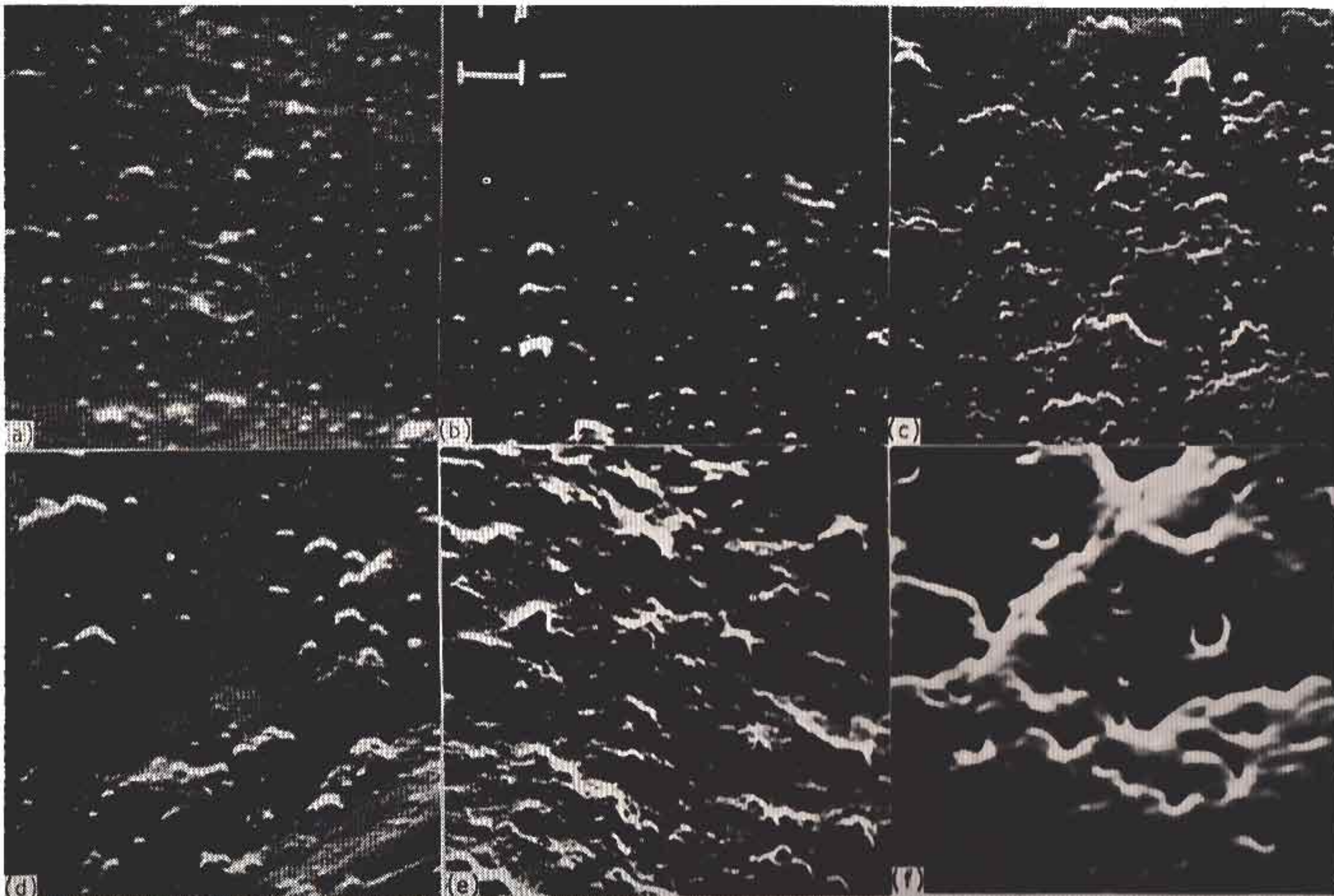

Fig. 2. Scanning electron microscope photomicrographs of Rennin clotted cows skim milk. Magnification 6000X.

(a) Casein micelles in cows skim milk
(b) Casein micelles in cows skim milk with Rennin after 5 min
(c) Casein micelles in cows skim milk with Rennin after 10 min
(d) Casein micelles in cows skim milk with Rennin after 20 min
(e) Casein micelles in cows skim milk with Rennin after 30 min
(f) Casein micelles in cows skim milk with Rennin after 1 hr

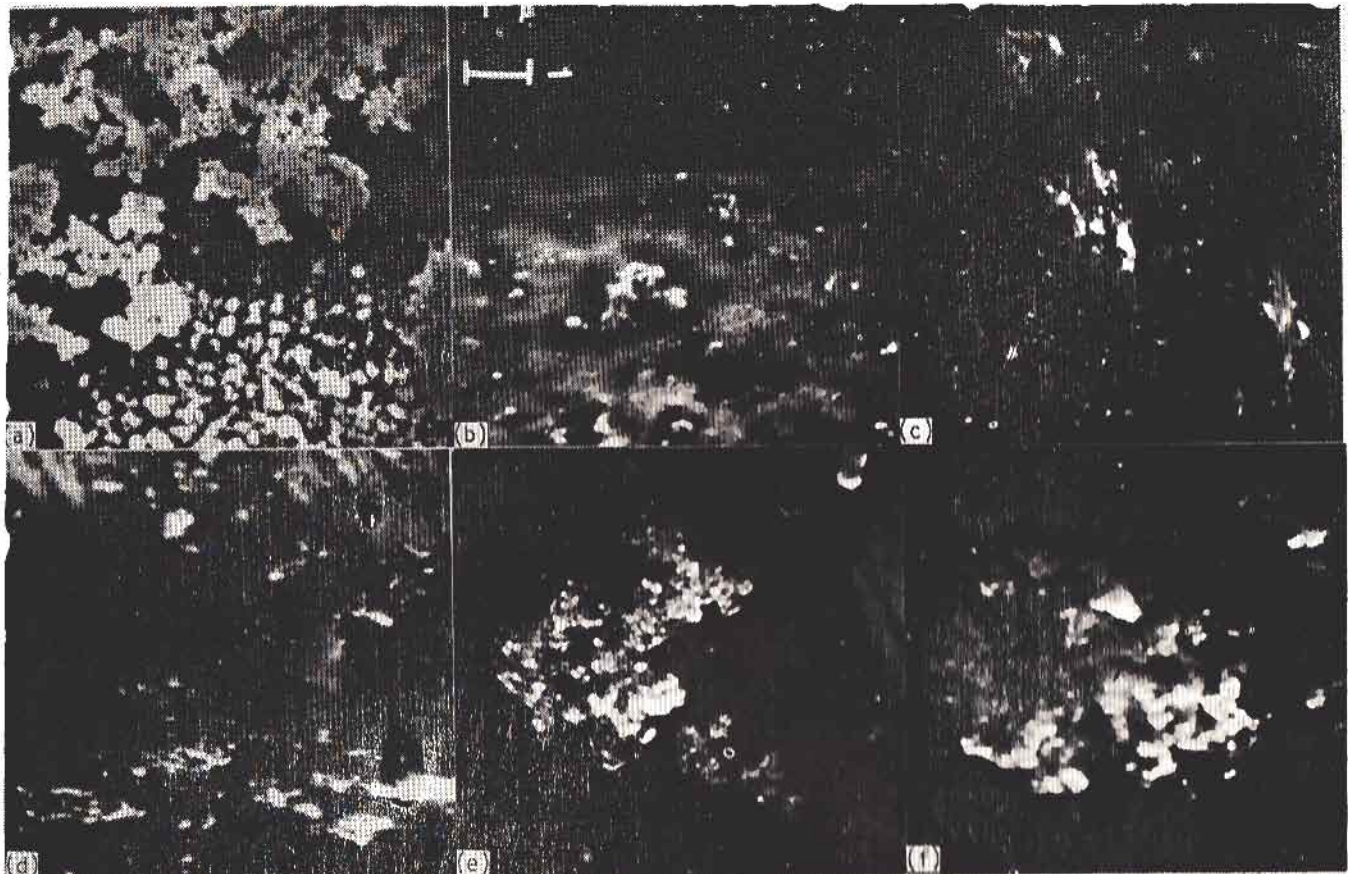

Fig. 3. Scanning electron microscope photomicrographs of Rennin clotted water buffalo whole milk. Magnification 6000X.

(a) Casein micelles in water buffalo whole milk
(b) Casein micelles in water buffalo whole milk with Rennin after 5 min
(c) Casein micelles in water buffalo whole milk with Rennin after 10 min
(d) Casein micelles in water buffalo whole milk with Rennin after 20 min
(e) Casein micelles in water buffalo whole milk with Rennin after 30 min
(f) Casein micelles in water buffalo whole milk with Rennin after 1 hr

TABLE 1

SIALIC ACID IN COWS AND BUFFALO MICELLAR CASEIN BEFORE AND AFTER THE ADDITION OF RENNET

| Milk | Sialic Acid Content of Casein Micelles Before and After The Addition of Rennet (mg/g of Casein) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 5 min | 10 min | 20 min | 30 min | 60 min |
| Cows whole milk | 3.96 | 3.10 | 2.15 | 1.11 | 0.61 | 0.52 |
| Cows skim milk | 4.18 | 3.65 | 2.81 | 1.21 | 0.49 | 0.31 |
| Buffalos whole milk | 2.65 | 1.89 | 1.15 | 0.45 | 0.20 | 0.10 |

This is in accord with the findings of Sabarual and Ganguli (1970). This may be due to the low level of *as*—casein in buffalo milk casein solution which may be associated with the low of K-casein. The results also show that between 10-15% of the sialic acid of buffalo casein released during the first 5 minutes after the addition of rennet, the release of sialic acid continued throughout rennin action; ofter 20 minutes about 65% for cow's whole milk, 70% for cow's skim milk and 89% for buffalo's whole milk of the sialic acid was released.

The more rapid coagulation of buffalo's milk by rennin and the less uniform and compact curd may be attributed to the low level of *as*—casein, the slow degradation of B-casein, the high level of Ca++ and the fast release of sialic acid buffalo milk casein.

Improvement in the qualities of hard cheese made from buffalo milk may be achieved by creating an inner association ratio of *as* to *B*—s casein close to 3 : 1 as in cow's casein. This suggests that formation of primary particles is not *as*— to *as*—casein nor *B*— to *B*—casein, but is an *as*— *B*—casein association.

The author wishes to express his sincere appreciation to the University of Baghdad and to the Food Science Department, University of Alberta for providing finances and facilities for conducting this research.

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