APPLICATION OF A GEOMETRICAL MODEL FOR YIELD AND ITS COMPONENTS OF SOME COTTON GENOTYPES (*G.barbadense* L.)

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Abstract

Yield model was developed for selected cotton genotypes (Gossypim barbadense. L). Yield was equated with the volume of rectangular parallelepiped having the following dimensions, bolls per square meter (X), seed per boll (Y) and seed cotton per seed (Z). Axis (Z) was divided into its two fractions, lint per seed (L/S) and weight per seed (SW/S). Meanwhile, lint yield was expressed by rectangular parallelepiped (XYL).Yield components of the selected genotypes were expressed as a percentage of Giza90 over five locations in Middle and Upper Egypt in 2007 season.

The results showed that, bolls per square meter (X axis) had the greatest influence on yield. Breeder expects that the greatest gain in yield improvement should come from exerting selection pressure on this character. Concurrent selection pressure should also be placed on seeds per boll (Y) and seed cotton per seed (Z). Data were presented to illustrate a use of model to define the component of yield more susceptible to alteration to increase yield.

INTRODUCTION

Breeder in cotton breeding programs aimed at the production of new varieties with high productivity and desirable fiber traits through selected strains which were examined in trial (B) grown in several locations.

Geometric yield model used was to compare the effects of various yield components on cotton yield. The material used in this study included the selected genotypes from Egyptian cotton breeding program at Middle and Upper Egypt in 2007 season. Atta et all (1989) used geometrical yield model and stated that the greatest gain in yield improvement can be reached by exerting selection pressure for more bolls per unit area followed by seed cotton per seed and seed per boll. Abou-Zahra et al (1993) expressed cotton yield and its components in a geometric model in which seed cotton yield was equated with volume of rectangular parallelepiped having the following dimensions (X), (Y) and (Z) equal to bolls per square meter, seed per boll and seed cotton per seed respectively. Axis (Z) was divided into two fractions, lint per seed (L) and weight per seed (S).Meanwhile, lint yield was expressed by the rectangular parallelepiped (X Y L). They showed that, bolls per square meter (X axis) had the greatest influence on yield followed by seeds per boll (Y) and seed cotton per seed (Z).

The objective of this study is to use the geometric yield model proposed by Kerr (1966) and Maner *et al.* (1971) to compare the effects of various yield components on yield of some genotypes (Gossypium barbadense L.) selected through cotton breeding program in Middle and Upper Egypt.

MATERIALS AND METHODS

Eighteen breeding lines were used in this study derived from fourteen hybrids, in addition to the two commercial varieties Giza90 and Giza80, were used in this study Table 1.

In 2007 season all genotypes were grown in a randomized complete block design experiment over five locations (Beni suief, El-Fayoum, El-Minia, Assuit and Sohag) with four replications for each experiment. Each plot consisted of eight rows 4 meter long, 60 cm apart and 20cm between hills. The hills were thinned to two plants/ hill. The six central rows of each plot were hand harvested to determine seed cotton yield per plot (in grams). A random sample of 50 bolls, were harvested from the two outer rows to determine boll weight, lint percentage and seed index. After ginning, fiber properties were tested for four replications.

Combined analysis of variance was performed over the five environments to detect the genotypes by environment interaction as described by Snedecor and Cochran (1967).

Yield model proposed by Kerr (1966) and Maner et.al (1971), was applied for ten genotypes which differed significantly from the check variety Giza90 in mean of seed cotton yield (based on the results of combined analysis over the five locations). Seven traits were calculated from the studied traits as follows:

1- Seed cotton yield g/m^2 (SCY/m^2) = plot yield (g) / plot area (m^2).
2- Bolls numbers per m^2 (B/m^2) = (SCY/m^2) / boll weight in (g).
3- Seed per boll (S/B) = boll weight (100 − L %) / seed index.
4- Seed cotton per seed (SCS) = boll weight / (S/B).
5- Lint per seed (L/S) = (SCS) x (L %).
6- Seed weight / seed (SW/S) = seed index / 100.
7- Lint yield in g/m^2 (LY/m^2) = (SCY/m^2) x (L %).
8- Number of fiber per seed (F/S) = (L/S) / (M/L) x (Mic).

The seed cotton yield, for each of the seven genotypes along with the check variety Giza90 was equated with the volume of a rectangular parallelepiped having dimensions x for bolls per unit area (B/m^2) , Y for seed per boll (S/B) and Z for seed cotton per seed (SCS). Axis Z was divided into two fractions, lint weight per seed (L) and weight per seed (S). Lint yield is the volume of X Y L.

Table 1. Pedigree of the cotton genotypes used in this study.

NO.	Strain	parents	Origin
1	H_5 95/2005	H_4 57/2004	[G83 x (G72 x Dan)] x G80
2	H_5 104/2005	H_4 73/2004	[G83 x (G72 x Dan) x G91
3	H_5 124/2005	H_4 81/2004	[G83 x (G72 x Dan)] x G85
4	H_5 141/2005	H_4 109/2004	[(G83 x G80) x G75] x (G83 x Pima S6)
5	H_5 146/2005	H_4 117/2004	[(G83 x G80) x G75] x Australian
6	H_5 149/2005	H_4 124/2004	G72 x Pima S6
7	H_6 161/2005	H_5 129/2004	[G83 x (G75 x 5844)] x [G83 x (G72 x Dan)]
8	H_6 162/2005	" "	" "
9	H_6 166/2005	H_5 145/2004	" "
10	H_6 173/2005	H_5 150/2004	[G83 x (G75 x 5844)] xG80
11	H_6 175/2005	H_5 151/2004	" "
12	H_6 188/2005	H_5 159/2004	[G83 x (G75 x 5844)] x (G80 x Pima S6)
13	H_7 203/2005	H_6 171/2004	(G83 x Delt 703) x (G83 x Pima S6)
14	H_7 213/2005	H_6 196/2004	G90 x Australian
15	H_7 221/2005	H_6 204/2004	G83 Radiator x G90
16	H_7 226/2005	H_6 209/2004	G91 x G90
17	H_7 227/2005	" "	" "
18	H_8 234/2005	H_7 213/2004	G83 x Pima S7
19	Giza90		G83 x Dan
20	Giza80		G66 x G73

RESULTS AND DISCUSSION

Yield components for Giza90 base model are expressed as 100% (Fig. 1), with three axes X (B/m²), Y (S/B) and Z (SCS). The yield box and its components for the line H_5 104/2005 of the hybrid [(Giza83 x (Giza72 x Dandara)] x Giza91 (Fig.2) showed that the yield component of bolls number per square meter (B/m²) was caused by increase from the base. The value for this axis (X) was only 117% of the corresponding value for Giza90. Yield of seed cotton and lint yield were 99.2% and 117%., respectively. Another yield component seed per boll (S/B) axis (Y) and seed cotton per seed (SCS) axis (Z) were 101% and 100% respectively, compared with the value base for Giza90. (Table 2 and Fig.2).

The yield box and its components for line H_5 124/2005 of the hybrid [(Giza83 x (Giza72 x Dandara)] x Giza91 (Table 2 and Fig3) indicated that the axis x (B/m²) contributed to the significant increase in its seed cotton yield and lint yield (115%) as compared to Giza90 and the effects was probablydue to B/m² (117%).

Yield components model for line H_5 141/2005 of the hybrid [(Giza83 x (Giza72 x Dandara)] x Giza85 indicated that the axis x (B/m²) was responsible for increase in seed and lint cotton yield 107% and 108%, respectively compared was Giza90 variety (Table 2 and Fig4)

The yield model and its components for lines H_6 161/2005, H_6 162/2005and H_6 166/2005 of the hybrid [Giza83 (Giza75 x 5844)] x [(Giza83 x (Giza72 x Dandara)] as shown in Fig (5, 6 and 7) indicated that the bolls number per square meter (B/m²)

axis $\dot{X}$ was responsible for their higher yielding ability in seed cotton yield (109%, 119% and 111%, respectively and lint yield (111%, 121% and 112%, respectively as compared with the base variety Giza90.

Table 2. Means of yield and yield components of the lines and cultivated varieties grown in B trails at five different locations in 2007 season.

No.	Genotype Strain	Origin	SCY/m^2	B/m^2	S/B	SC/S	L/S	SW/S	LY/M^2
1	H$_5$ 95/2005	[G83 x (G72 x Dan)] // G80	-365.59	126.22	17.93	0.266	0.066	0.103	147.50
2	H$_5$ 104/2005	[G83 x (G72 x Dan)] // G91	418.44**	135.38	18.39	0.272	0.066	0.103	164.06
3	H$_5$ 124/2005	[G83 x (G72 x Dan)] // G85	408.23	134.99	17.93	0.274	0.067	0.103	160.99.
4	H$_5$ 141/2005	[(G83 x G80) x G75] // (G83 x Pima S6)	379.10	124.11	18.27	0.271	0.067	0.100	151.44
5	H$_5$ 146/2005	[(G83 x G80) x G75] // Australian	378.33	125.57	18.10	0.266	0.067	0.101	150.50
6	H$_5$ 149/2005	G72 // Pima S6	336.01	108.34	18.65	0.267	0.067	0.100	133.77
7	H$_6$ 161/2005	[G83 x (G75 x 5844)] // [G83 x (G72 x Dan)]	393.02**	125.58	18.88	0.266	0.067	0.101	156.21
8	H$_6$ 162/2005	" "	422.99	138.58	18.16	0.272	0.068	0.103	168.39
9	H$_6$ 166/2005	" "	393.26	131.48	17.55	0.272	0.068	0.103	156.71
10	H$_6$ 173/2005	[G83 x (G75 x 5844)] // G80	438.44**	141.60	18.30	0.270	0.068	0.101	175.94
11	H$_6$ 175/2005	" "	413.96**	134.01	18.19	0.273	0.068	0.104	163.68
12	H$_6$ 188/2005	[G83 x (G75 x 5844)] // (G80 x Pima S6)	386.01	126.28	18.46	0.267	0.067	0.102	152.75
13	H$_7$ 203/2005	(G83 x Delt 703) // (G83 x Pima S6)	376.67	125.96	18.12	0.267	0.068	0.101	150.88
14	H$_7$ 213/2005	G90 // Australian	401.22**	134.83	17.68	0.271	0.067	0.103	156.78
15	H$_7$ 221/2005	G83 Radiator // G90	395.28	132.05	17.56	0.272	0.067	0.104	155.39
16	H$_7$ 226/2005	G91 // G90	379.46**	128.15	17.68	0.270	0.067	0.104	149.30
17	H$_7$ 227/2005	" "	427.85	143.54	17.90	0.264	0.066	0.101	168.71
18	H$_8$ 234/2005	G83 // Pima S7	389.69**	126.48	18.13	0.269	0.068	0.103	155.03
19	Giza90	G83 // Dan	354.13	115.27	18.26	0.272	0.067	0.103	139.74
20	Giza80	G66 // G73	333.65	114.24	18.10	0.268	0.065	0.101	130.03

*, Highly significant at 1% level of probability.

The yield models for lines H_6 173/2005 and H_6 175/2005 of the hybric [(Giza83 x (Giza75 x 5844)] x Giza80 showed that the bolls per square meter (B/m^2) axis (X) was responsible for their higher yielding ability in seed cotton yield (123% and 117% respectively) and lint yield (126% and 117% respectively) as compared with the base variety Giza90 (Fig 8 and 9).

Regarding to hybrid [Giza83 (75x5844)] x (Giza80 x Pima S6), line H_5 188/2005 (Fig 10) exceeded significantly the check variety Giza90 in seed cotton yield and lint yield by 109%, these increments caused by increasing bolls number per square meter (B/m^2) axis X , which was 110% (Table 2 and Fig 10).

The yield model and its components for line H_7 213/2005 of the hybrid (Giza90 x Australian) (Fig. 11) reiterate the effect of bolls per unit aria on yield, when bolls number per square meter (B/m^2) value was 117%, seed cotton and lint yields were 113% and 112% compared with Giza90 variety. Another components that also influence in yield was seed per boll (S/B) axis (Y) 97% compared with Giza90 and seed cotton per seed (SCS) axis (Z) which relatively had the same value as Giza 90.

Yield model and its components for the line H_7 221/2005 (Giza83 Radiatored x Giza90) as shown in Table (2) and Fig (12), indicated that boll number per square meter (B/m^2) was 115% and showed an increase in seed cotton yield (111%) as compared by the check variety Giza90.

The yield box and its components for lines H_7 226/2005 and H_7 227/2005 of the hybrid (Giza91 x Giza90) (Fig.13 and 14) indicated that the bolls number per square meter (B/m^2) was responsible for the significant increase in its seed cotton yield by 107% and 121%, respectively and lint yield by 106% and 121%, respectively, as compared with the base variety Giza90. B/m^2 axis X recorded 111% and 125%, respectively.

However, the seeds per boll (S/B) axis (Y) and seed cotton per seed (SCS) axis (X) for line H_8 234/2005 of the hybrid (Giza83 x Pima S7) were lower than that obtained for Giza90 (99%), its seed cotton yield and lint yield were significantly lower than that of Giza90 (110% and 111%), respectively. The main effect was due to B/m^2 (110%), Table (2) and Figar (15).

Generally the importance of the (X) axis and the influence of the (Y) and (Z) axes, from the standpoint of the contribution mode to yield are evident in this study. We believed that the greatest gain in yield can be obtained by exerting selection pressure for more bolls per unit area (X axis). Concurrent selection pressure should also be placed on seed per boll (Y axis) and seed cotton per seed (Z axis). Therefore, cotton breeder must direct his program to select plants with the highest number of bolls per

plant, seeds per bolls and seed cotton per seed concomitantly to maintain or to increase lint per seed. These results are in harmony with those obtained

Kerr (1966), Shafshak et al., (1987), Atta et al., (1989) and Abou-Zahra et al., (1993).

The correlation coefficients of lint yield components are shown in Table (2). These data indicate highly significant and significant positive correlation between micronaire value (Mic) with upper half mean length (UHM), lint yield per square meter (LY/M^2) and number of bolls number per square meter (B/M^2). On the other hand the micronaire value (Mic) recorded significant negative correlation with number of fiber per seed (F/S) and lint per seed (L/S). Highly significant positive correlation was found between number of fiber per seed (F/S) and lint per seed (L/S), while it was negatively significant correlated with seed per boll (S/B), lint yield per square meter (LY/M^2) and number of bolls number per square meter (B/M^2). Highly negative significant and significant correlation was found between lint per seed (L/S) and number of bolls number per square meter (B/M^2). Seed per boll (S/B) shows significant negative correlation with lint yield per square meter (LY/M^2). Highly significant positive correlation was obtained between number of bolls per number square meter (B/M^2) and lint yield per square meter (LY/M^2) as would be logically expected.

Table 3. Correlation coefficients of lint yield and its components.

	UHM	F/S	L/S	S/B	B/M2	LY/M2
Mic	0.358**	-0.003*	-0.002*	0.219	0.310*	0.420**
UHM		0.014	0.016	0.151	-0.078	0.032
F/ S			0.981**	-0.494**	-0.078*	-0.153**
L/S				-0.443**	-0.142*	0.195
S/B					-0.086	-0.145*
B/M^2						0.933**
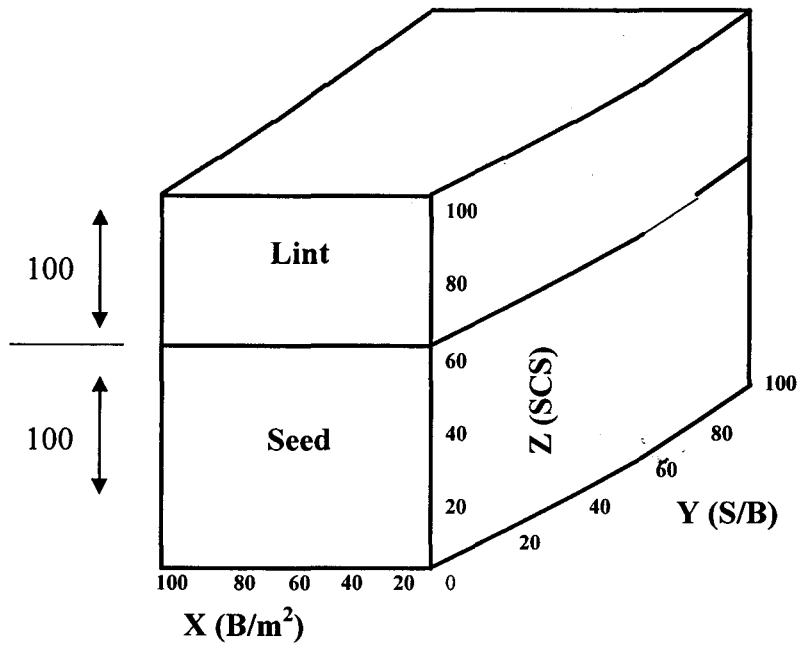
Fig 1. Yield model for Giza90 extracted from (Five locations experiment means expressed as percentage of Giza90).
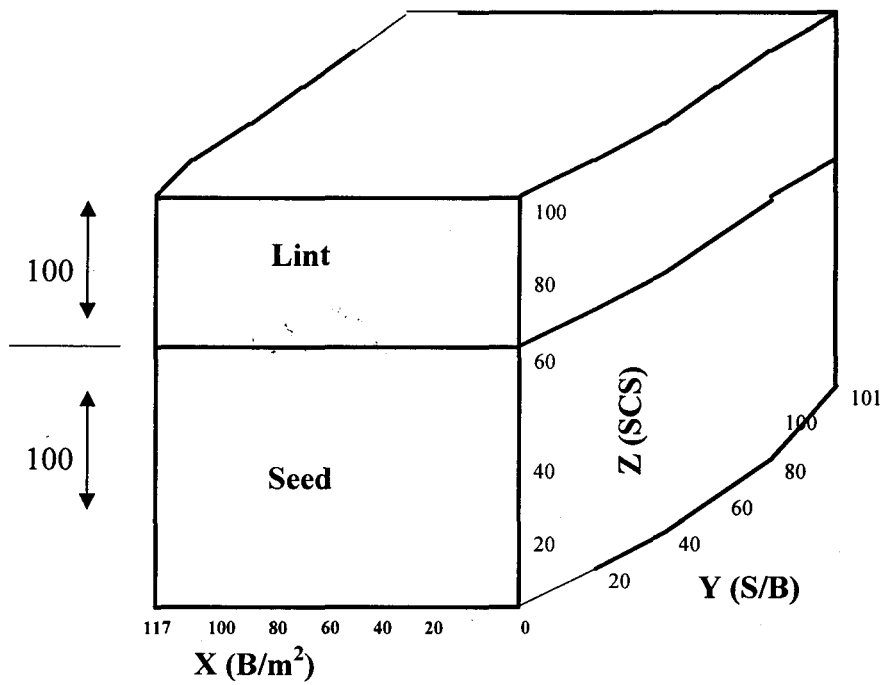

Fig 2. Yield model for H5 104/2005 [(G83x (G72xDan) xG91] extracted from (Five locations experiment means expressed as percentage of Giza90).
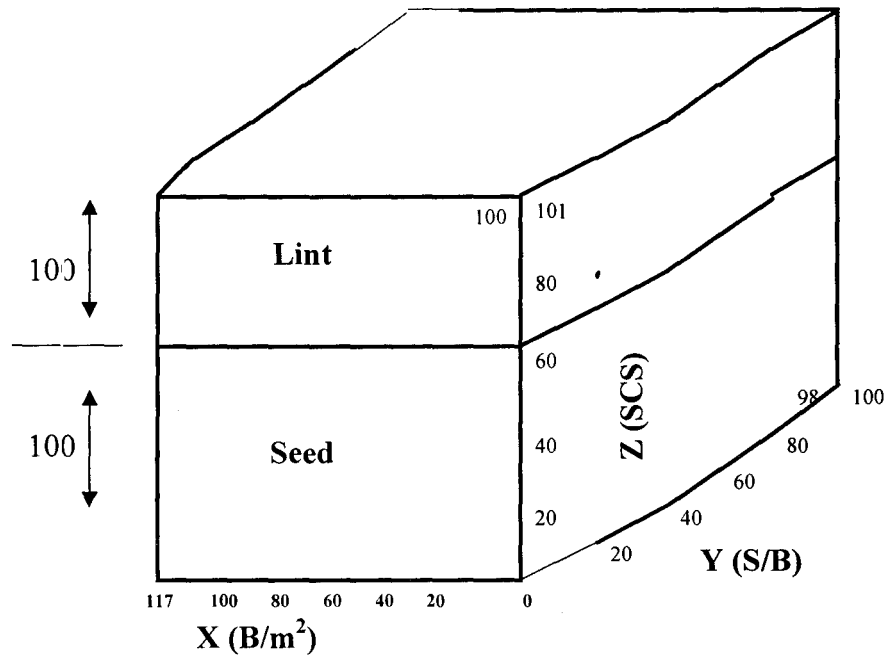
Fig 3. Yield model for H_5 124/2005 [(G83x (G72xDan) xG85 extracted from (Five locations experiment means expressed as percentage of Giza90
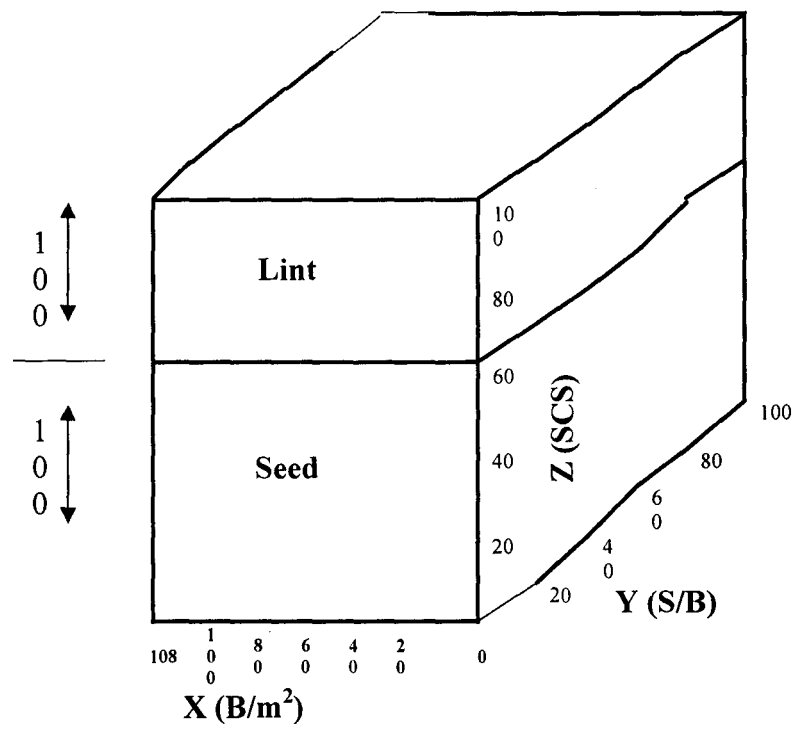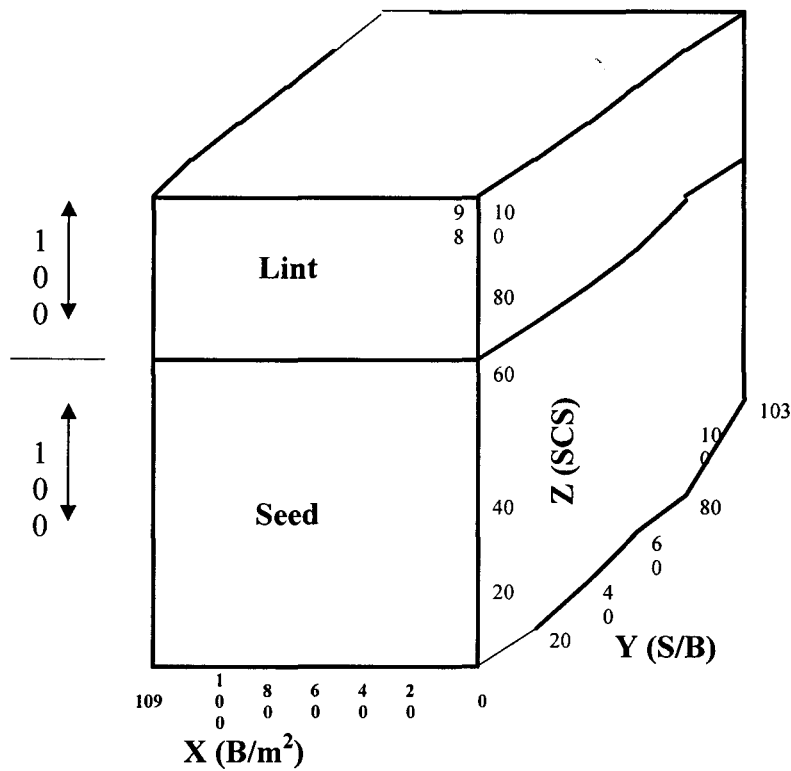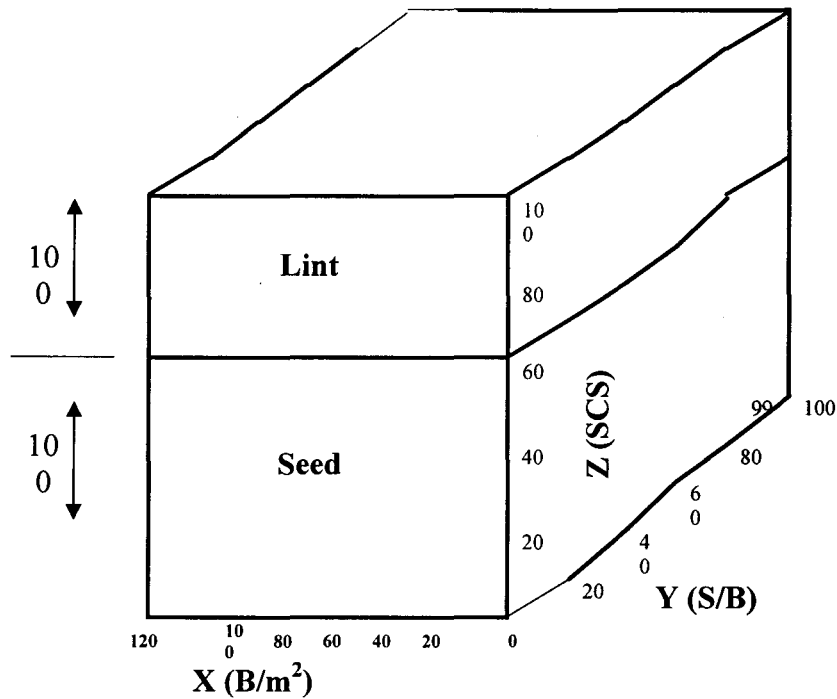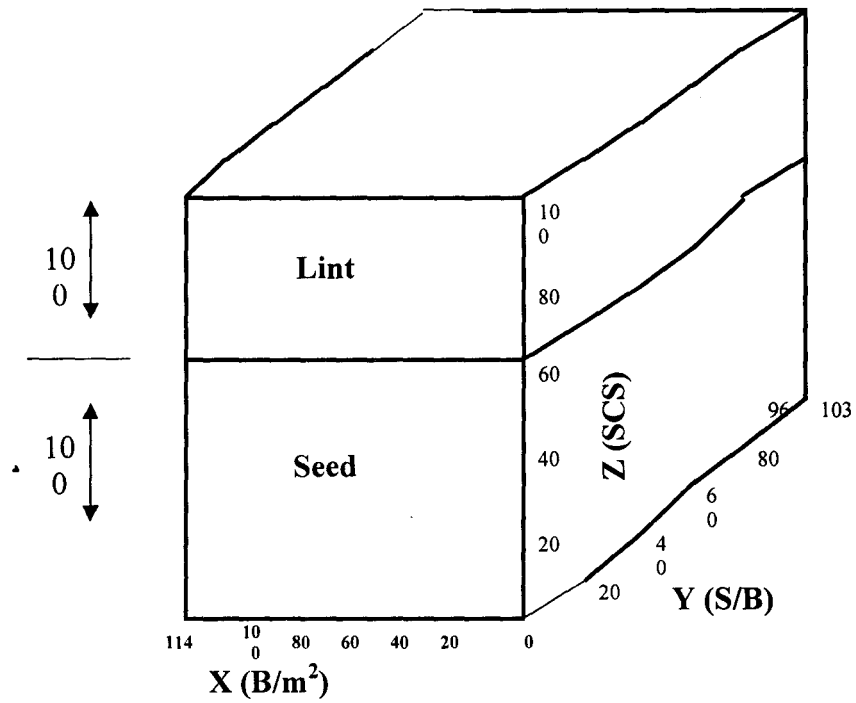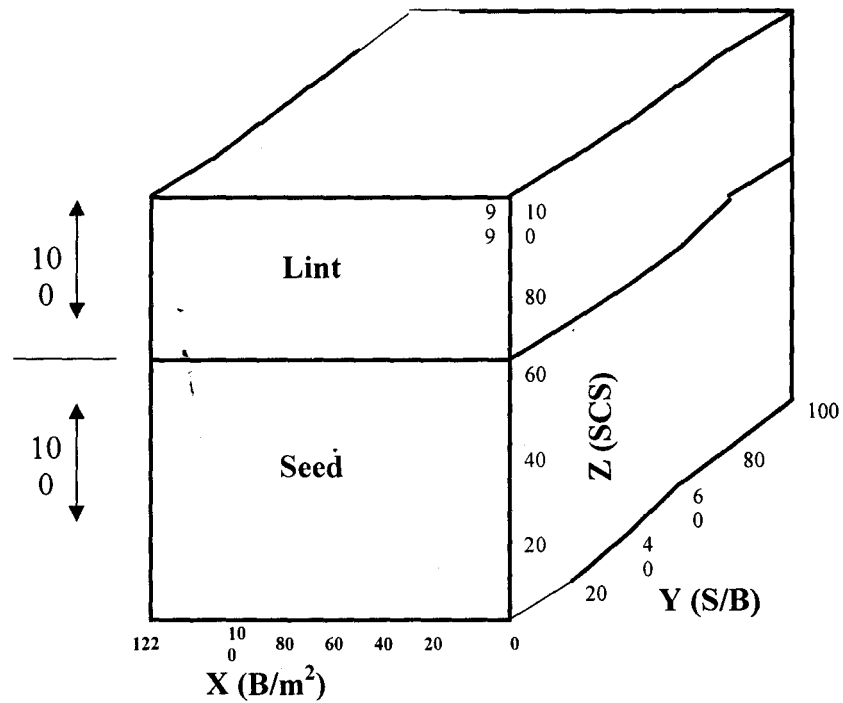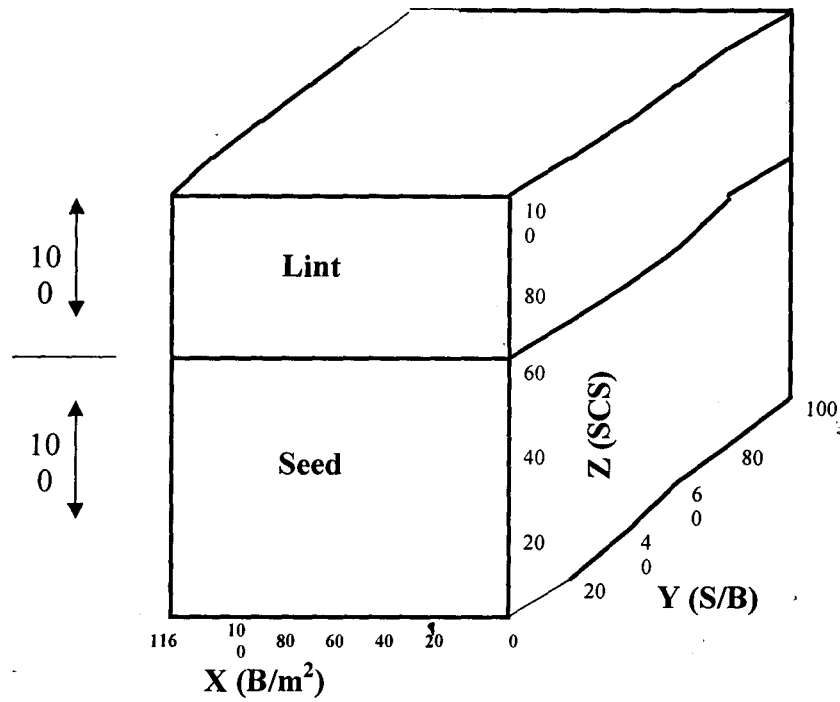

Fig 4. Yield model for H_5 141/2005 [(G83xG80) xG75] x (G83xPima S6) extracted from (Five locations experiment means expressed as percentage of Giza90).

Fig 5. Yield model for H_6 161/2005 [G83x(G75x5844)] x [G83x(G72xDan)] extracted from (Five locations experiment means expressed as percentage of Giza90).

Fig 6. Yield model for H_6 162/2005 [G83x(G75x5844)] x [G83x(G72xDan)] extracted from (Five locations experiment means expressed as percentage of Giza90).

Fig 7. Yield model for H6 166/2005 [G83x(G75x5844)] x [G83x(G72xDan)] extracted
from (Five locations experiment means expressed as percentage of Giza90

Fig 8. Yield model for H6 173/2005 [G83x (G75x5844)] x G80 extracted from (Five
locations experiment means expressed as percentage of Giza90).

Fig 9. Yield model for H6 175/2005 [G83x(G75x5844)] x G80 extracted from (Five locations experiment means expressed as percentage of Giza90
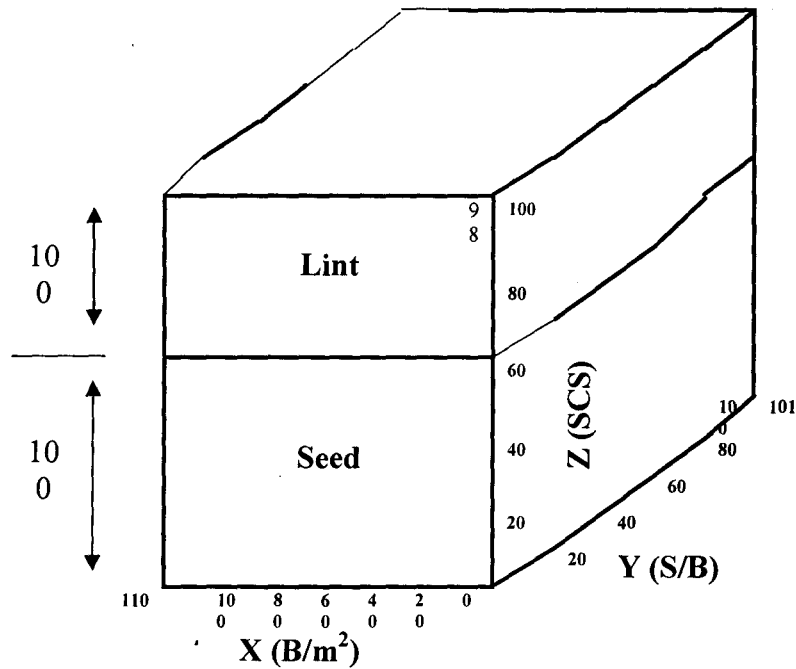

Fig 10. Yield model for H6 188/2005 (G83 x G75 x 5844) x (G80 x Pima S6) extracted from (Five locations experiment means expressed as percentage of Giza90).
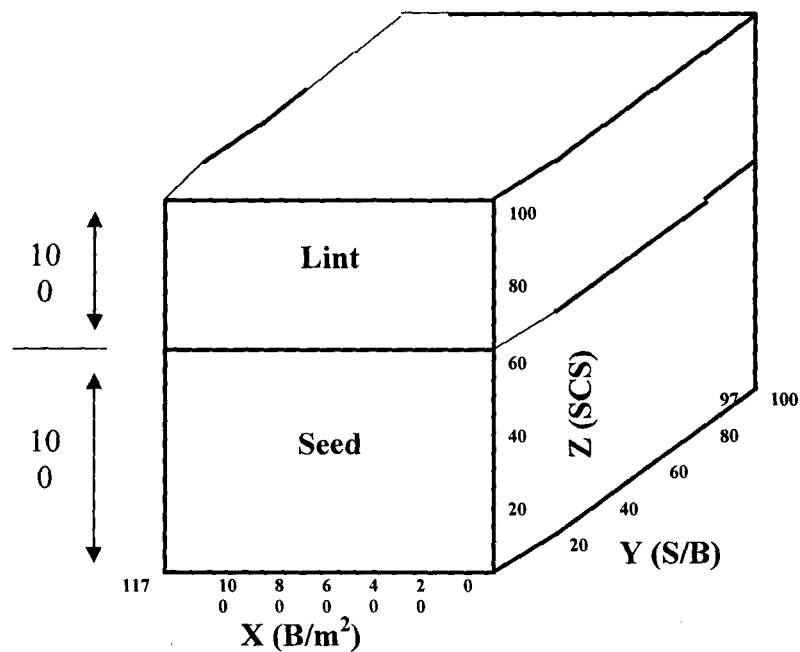
Fig.11. Yield model for H7 213/2005 (G90 x Australian) extracted from (Five locations experiment means expressed as percentage of Giza90).
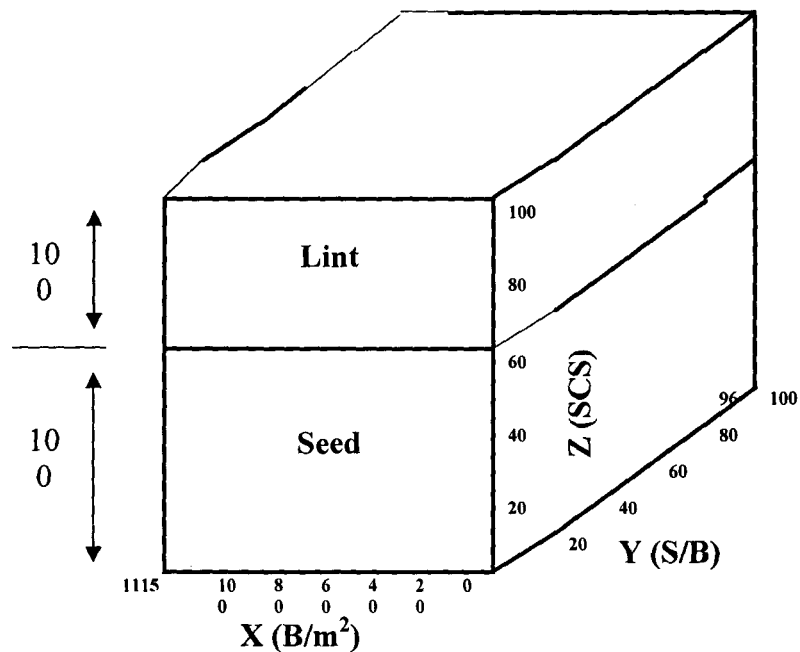

Fig 12. Yield model for H7 221/2005 G83 Radiator x G90) extracted from (Five locations experiment means expressed as percentage of Giza90).
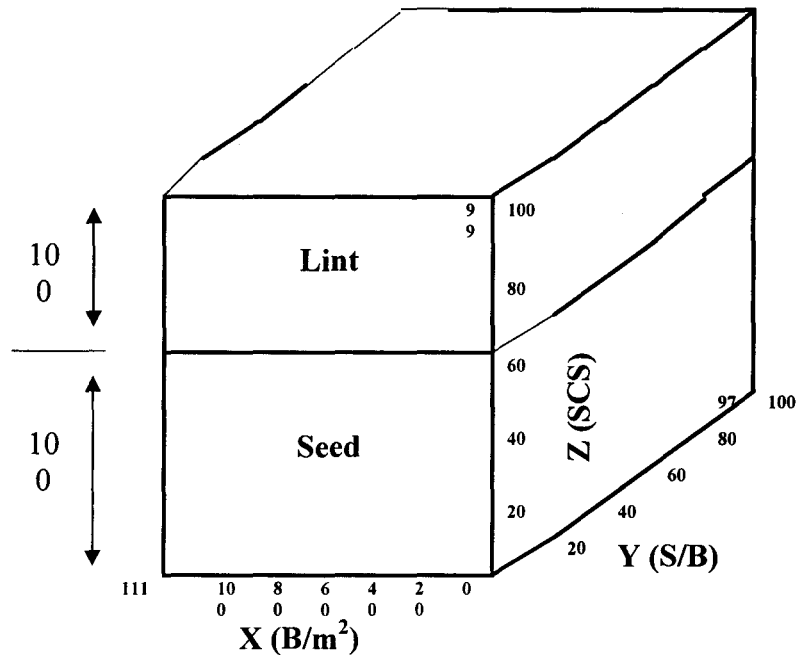
Fig 13. Yield model for H7 226/2005 (G91xG90) extracted from (Five locations experiment means expressed as percentage of Giza90).
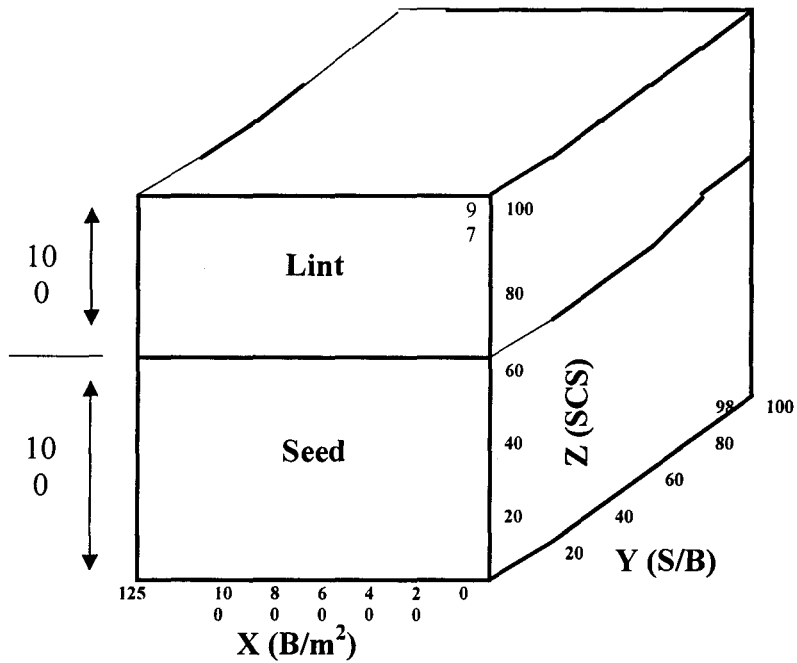

Fig 14. Yield model for H6 227/2005 (G91 x G90) extracted from (Five locations experiment means expressed as percentage of Giza90).
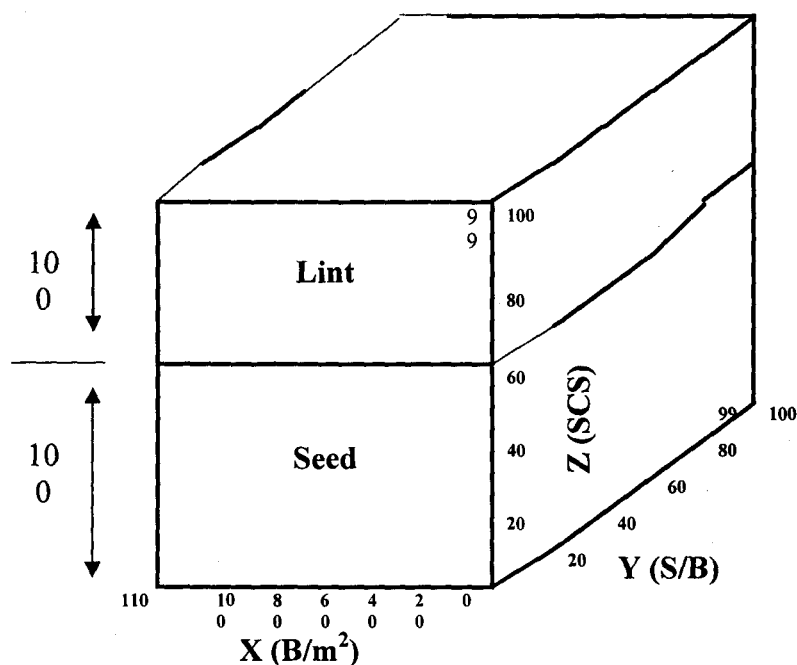
Fig 15. Yield model for H7 213/2005 (G83 x Pima S7)) extracted from (Five
locations experiment means expressed as percentage of Giza90).

REFERENCES

1- Abou-Zahra, S.I.S, M.M. Awaad and Foraisa A. Al-Enani. 1993. Geometrical model
of cotton yield and its components of some genotypes through a breeding
programme in Middle and Upper Egypt. Zagazig J. Agric. Res. Vol.20
No.(2A)1993: 551-558.

2- Atta, Y.M., S.A. El-Shaarawy, M.A.A. Raafat and M.R.A. Rahoumah. 1989.
Geometrical model for yield and yield components of some genotypes through a
breeding programme for Egyptian cotton. Annals of Agric. Sci., Moshtohor, 22:
169-178, Egypt.

3- Kerr, T. 1966. Yield components in cotton and their interrelationships with fiber
quality. Proc. 18th Cotton Improvement Conf., P. 276-287.

4- Maner,B.A., L.S. Worly, D.V. Harrell and T.W. Culp. 1971. Ageometrical approach
to yield models in upland cotton (G.hirsutum L.). Crop Sci., 11: 904-906.

5- Snedecor, G.W. and W.G. Cochran. 1967. Statistical methods. 7th Edition, Iowa
State Univ. Press, Ames, Towa, U.S.A. PP.325-330.

6- Shafshak, S.E., A.A. Sallam, M.K. Khalifa and M. M. Awaad. 1987. The relative
contribution of yield components to lint yield of some cotton varieties. Agric. Res.
Rev., 65: 589-613.

النموذج الهندسى لمحصول القطن ومكوناته لبعض التراكيب الوراثية
(نوع الباربادينس)

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تم دراسة النموذج الهندسى لمحصول القطن ومكوناته وذلك لعدد سبعة تراكيب وراثية والتى أظهرت معنوية مقارنة بالصنف المنزرع جيزة ٩٠ وذلك من خلال تجارب المحصول ب والمقامة فى خمس محافظات بالوجة القبلى وهى الفيوم – بنى سويف – المنيا – أسيوط – سوهاج خلال موسم ٢٠٠٧ وذلك من خلال تمثيل القطن الزهر بالشكل متوازى المستطيلات ذو ثلاثة ابعاد وهى عبارة عن عدد اللوز فى المتر المربع (X) وعدد البذور فى اللوزة (Y) ووزن القطن الزهر بالبذرة (Z) وقد تم تقسيم المحور (Z) الى جزئيين يمثلان وزن الشعر على البذرة (L/S) ووزن البذرة (SW/S) بحيث يصبح محصول القطن الشعر مساوى لحجم متوازى المستطيلات (XYL).

أوضحت النتائج أن الزيادة فى المحصول تكون ناتجة عن زيادة عدد اللوز فى المتر المربع وبالتالى يمكن أن يقوم المربى بالأنتخاب لهذه الصفه مما تساعده على زيادة محصول القطن.

كذلك يجب أن يضع المربى فى اعتباره عند الأنتخاب زيادة عدد البذور باللوزه وكذلك محصول القطن الزهر بالبذرة لأن ذلك سوف يعطى له قدرة فى الحفاظ على زيادة المحصول لأعلى مستوى من الأصناف التجارية المنزرعة وبالتالى يستطيع انتاج هجن وأصناف ذات قدرة محصولية عالية تحل محل الاصناف المنزرعة.