台東區農業改良場研究彙報 1： 1 ～ 9 （1987）
Bull. Taitung DAIS

USE OF ECONOMIC CHARACTERS AS IDEOTYPES IN ASPARAGUS BREEDING

Yung-Wu Chen[1]

Key Words: Ideotypes, Breeding, Asparagus.

SUMMARY

Time required to perform any breeding program for a perennial like asparagus is generally lengthy. The use of economic characters as ideotypes in asparagus breeding may shorten the time considerably, and it is comparatively easy to eliminate defects.

The economic characters as ideotypes are defined as follows:

1. Number of stalks in relation to yield and numbers of spears.
2. Long stalks giving a high yield.
3. Crown size, related to yield and number of stalks, a large crown means vigorous growth, giving high yields.
4. The height of the first branch of the stalk: This affects the tightness of the spear tip.
5. The diameter of the stalks, larger stalks produce larger spears, but also give fewer spears and a lower yield.

In this paper, the concept of the ideotype is discussed in relation to data derived from two cultivar trials and correlation coefficients are given for several of the ideotype characters.

The use of economic characters as ideotypes was also applied to the breeding program which resulted in the release of three new varieties, Tainan selection No. 1, Tainan selection No. 2 and Tainan selection No. 3.

INTRODUCTION

Most plant breeding is based on defect elimination or the selection for yield through developed methods of plant breeding. A valuable additional approach is available through

1. Director,Taitung District Agricultural Improvement Station, Taitung, Taiwan ROC.

the breeding of crop ideotypes.[16] Ideotypes are models of plants which are expected to react in a predictable manner in a defined environment,[6] even in different climates.

Asparagus is a perennial crop. High yielding plants can not be selected accurately according to their performance during the first few years, and do not reach peak performance until after six to eight years,[12] so that any asparagus breeding program takes a long time to carry out. This paper outlines an attempt to find out correlation between economic characteristics such as yield and quality, which are considered to represent plant ideotypes. These can be used in a breeding program to shorten the breeding period and make it much easier to eliminate defects and to select superior plants.

THE FIELD TRIALS

The data for correlation studies of plant characteristics were gathered from a selection of 1120 plants in a seven-year-old field of cv. UC 309 and 1057 plants in a six-year-old field of cv. UC 711. The yield of individual plants was investigated by cutting green spears. The plant characteristics were recorded at the rest period, during the winter season. The so-called "mother stalk method" was used to produce spears. Spears were cut every day during the harvest period, and each individual plant was weighed and recorded separately. Standard frozen processing of aspuragus[5] was used to study the spear quality. During the harvest periods, yield data were taken as follows:

1. Spear size and weight.
2. Appearance of spear tip.
3. Presence or absence of abnormal spears.

In the rest period during the winter season, data of the plant characteristics were taken as follows:

1. Number of stalks.
2. Stalk height.
3. Average diameter of stalks.
4. The first branch height of stalks.
5. Crown size.

Data on the correlation between characteristics were analyzed at the National Taiwan University(NTU) Computer Center.

THE IDEOTYPE

STALK NUMBER

High yield is the most important feature in crop production. The yield of individual

asparagus plant was found to have a highly significant positive correlation to the number of stalks, in tested varieties of UC 309 and UC 711 (Tables 3 and 4). This shows that the greater the number of stalks produced by the plant, the higher the total yield (Tables 1 and 2). Similar results were also obtained by Sawada[14] and Ellison[7,8]. The stalk number of the ideotype can therefore be recommended as a means of determining the selection during the rest season of the superior plant which will produce a high yield of spears.

HEIGHT OF STALK

The yield of individual plant had a highly significant positive correlation to the height of the stalks in UC 711 and a positively correlation in UC 309 variety (Tables 3 and 4). This indicates that small and dwarf plants have poor growth and lower yields (Tables 1 and 2). The characteristic of plant height can be considered an ideotype in the selection of superior plants.

Table 1. Relation between plant characters and yield in variety UC 309.

Yield per plant (g)	No. plants	Average no. spears	Average no. stalks	Average height of stalks (cm)	Average diameter of stalks (cm)	Average height of first branch (cm)	Average size of crown (cm)
Above 1000	36	67	6.27	176.56	0.95	51.67	47.70
801–1000	78	57	5.42	172.46	0.87	53.11	45.21
601–800	167	44	5.38	171.58	0.88	51.97	41.91
401–600	283	32	4.66	172.51	0.88	52.27	39.36
201–400	326	20	3.77	171.68	0.89	52.88	29.66
Below 200	131	11	2.98	163.98	0.88	51.86	21.28
Total	1021						
Average		39	4.75	171.46	0.89	52.29	37.35

Table 2. Relation between plant characters and yields in variety UC 711.

Yield per plant (g)	No. plants	Average no. spears	Average no. stalks	Average height of stalks (cm)	Average diameter of stalks (cm)	Average height of first (cm)	Average size of crown (cm)
Above 801	20	69	6.79	196.86	0.84	52.21	41.79
601–800	56	47	6.64	189.63	0.84	52.94	41.76
401–600	150	35	5.57	187.89	0.82	55.66	36.85
201–400	439	24	4.57	182.59	0.83	52.38	30.82
Below 200	358	11	3.59	178.21	0.83	51.90	24.46
Total	1023						
Average		37	5.43	187.04	0.83	53.02	35.14

Table 3. Correlation of characters in variety UC 711.[a]

Characters	Total yield	No. spears	No. stalks	Height of stalks	Diameter of stalks	Height of first branch
No. spears	0.851**					
No. stalks	0.355**	0.450**				
Height of stalks	0.166**	0.082**	-0.002^{NS}			
Diameter of stalks	0.019^{NS}	-0.205**	-0.310**	0.191**		
Height of first branch	0.038^{NS}	-0.039^{NS}	0.004^{NS}	0.477**	0.230**	
Crown size of stalks	0.376**	0.362**	0.513**	0.157**	–0.124**	0.086**

a. Analyzed by NTU Computer Center.
**Significant at 1% level (df=1023-2=1021, p=1%, r=0.081).

CROWN SIZE

A larger crown produced a higher yield of spears (Tables 1 and 2). A high positive correlation was found between the yield of individual plants and crown size. Crown size was also highly significant and positively correlated to the number of stalks (Tables 3 and 4). Similar results were obtained by Hable.[11] A large crown gives vigorous growth and high yields, which is why it is a good ideotype.

HEIGHT OF FIRST BRANCH OF STALK

Lower temperatures produced tighter spear tips, while higher temperature tends to produce loosened spear tips. The experimental results in Taiwan indicated that Californian varieties produced tighter spear tips than those of New Jersey[9,10], probably because the climate in Taiwan is closer to that of California than to that of New Jersey. The height of the first branch of the stalk is related to the tightness of the spear tips. Results of the study found that the tightness of the spear tips was not only affected by the variety, the climate, the soil type and soil moisture[3,4,9,10], but also correlated to the height of the first branch of the stalk (Tables 5 and 6). In order to improve the tightness of the spear tips under tropical conditions, the height of the first branch of the stalk should be considered an ideotype in breeding programs.

Table 4. Correlation of characters in variety UC 309.[a]

Character	Total yield	No. spears	No. stalks	Height of stalks	Diameter of stalks	Height of first branch
No. spears	0.820**					
No. stalks	0.318**	0.483**				
Height of stalks	0.066*	0.040^{NS}	0.045^{NS}			
Diameter of stalks	0.010^{NS}	-0.206**	-0.346**	0.253**		
Height of first branch	0.057^{NS}	-0.036	0.053^{NS}	0.493**	0.189**	
Crown size of stalks	0.321**	0.355**	0.577**	0.094**	-0.146**	0.061^{NS}

a. Analyzed by NTU Computer Center.

* Significant at 5% level.

** Significant at 1% level (df=1021-2=1019, p=1%, r=0.081, p=5%, r=0.062).

STALK DIAMETER

Tables 3 and 4 showed that, even though there was no positive correlation between the average diameter of stalks and yield, generally, the larger the stalks the plants produced, the fewer the number of spears and the lower the spear yield. These results are similar to those reported by Tiedjens[16] and Robbins and Jones.[14] Larger stalks also crack more easily close to the ground, and this shortens the life of the stalks.

Because in the high temperatures of the tropics a modified method of asparagus culture is used, the so-called "mother stalk culture". A medium size stalk around 1.0 cm in diameter can be considered an ideotype.

Table 5. Relation between the height of the first branch on the stalk and the tightness of the spear.

Height of first branch on stalk (cm)	UC 309		UC 711	
	No. plants	Average tightness (%)	No. plants	Average tightness (%)
Above 70	45	90.36	93	92.69
60–69	220	87.86	181	88.34
50–59	405	82.87	374	84.12
Under 49	351	75.54	375	75.10
Total	1021		1023	
Average		84.56		85.06

Table 6. Correlation coefficient between height of the first branch of the stalk and tightness of the spear.

Variety	Correlation coefficient
UC 309	0.9945 ± 0.0534**
UC711	0.9968 ± 0.0462**

** Significant at 1% level (df=4-2=2, p=1%, r=0.9900).

APPLICATION OF ASPARAGUS IDEOTYPES

The asparagus ideotypes were applied to the breeding programs which resulted in the new release of the varieties Tainan Selection No. 1, Tainan Selection No. 2 and Tainan Selection No. 3. These three varieties were developed by mass selection from UC 309, Mary Wahington, and UC 711 varieites, respectively. All showed vigorous growth, high yields, tight tip, uniform spears etc.. The yield and plant characteristics are showing in Table 7.

Table 7. Comparison of plant characteristics and yield in original and new varieites.

Variety	Total yield (kg/ha)	Stalk no.	Stalk height (cm)	First branch of stalk (cm)	Crown diameter (cm)	Stalk diameter (cm)
UC 309 (Original variety)	12,650	3.80	153	41	33	1.01
Tainan Selection No. 1	14,330	4.10	163	52	35	0.96
Mary Washington (Original variety)	8,645	3.47	156	42	32	0.91
Tainan Selection No. 2	8,935	3.70	175	54	37	0.95
UC 711 (Original variety)	9,350	3.68	156	45	32	0.98
Tainan Selection No. 3	10,625	3.75	171	52	38	0.99

* Plant characteristics were measured as an average of 40 plants, 10 plants each replication.

DISCUSSION

The design of crop ideotypes is likely to improve crop characteristics in terms of their adatpation to a particular environment, even though this is unlikely to be suited to all crops. However, the use of characteristics as ideotypes in crop improvement should be a logical step as part of the design, breeding and testing program, to achieve new levels of yield and quality.

The ideotypes of wheat[6] and of chrysanthemum for summer flowering[13] have already been designed. We consider that such ideotypes will be even more important and valuable in the breeding of perennial crop such as asparagus, in which usually will take such a long time to develop new varieties.

REFERENCE

1. Blixt, S.G. and Vose, P.B. 1984. Breeding towards an ideotype – Aiming at a moving target? pp. 414-426. In Vose, P.B. and Blixt, S.G. (eds.). *Crop Breeding.* Pergamon Press, Oxford, England.
2. Chen, Y.W. 1974. Studies on the growth of green asparagus spears in tropical zone. *Res. Bulletin of Tainan DAIS.* 7:1-5.
3. Chen, Y.W. 1973. Studies on row material quality improvement of frozen green asparagus for exportation. Hort. Soc. China, 19,4: 251-254.
4. Chen, Y.W. 1979. Correlation of economic characters in asparagus. *Proceedings of the 5th International Asparagus Symposium. Eucarpia, Section Vegetable.* Forschungsanstalt Geisenheim , West Germany. pp. 258-267.
5. Department of Agriculture and Forestry, Taiwan Province. 1973. *Handbook for asparagus production and marketing.* pp. 75-81.
6. Donald, C.M. 1968. The breeding of crop ideotypes. Euphytica 17: 385-403.
7. Ellison, J.H. and Scheer, D.F. 1958. Yield related to brush vigor in asparagus. *Proc. Amer. Soc. Hort. Sci.* 73:339-344.
8. Ellison, J.H., Scheer, D.F. and Wagner, J.J. 1960. Asparagus yield as related to plant vigor, earliness and sex. *Proc. Amer. Soc. Hort. Sci.* 75:411-415.
9. Fengshan Tropical Horticultural Experiment Station. 1967. Observation on asparagus introduced varieties. *1967 Taiwan Asparagus Research Reports* p. 19.
10. Fengshan Tropical Horticultural Experiment Station. 1969. Observation on asparagus introduced varieties. *1969 Taiwan Asparagus Research Reports* pp. 11-18.
11. Hable, E.S. 1932. Effect of size of crown and length of cutting season on yield of asparagus. *J. Agri. Res.* (U.S.) 45,2:101-109, (Abst. in *Proc. Amer. Soc. Hort. Sci.* 28:309).
12. Hanna, G.C. 1941. Correlation studies of asparagus comparing yield of various shorter period with ten-year yield. *Proc. Amer. Soc. Hort. Sci.* 41:321-323.
13. Langton, F.A. and Cockshull, K.E. 1976. An ideotype of chrysanthemum. *Acta Horticulturae* 63:165-175.
14. Sawada, E.K. 1962. *Asparagus.* Japan. pp. 193-196.
15. Robbins, W.W. and Jones, H. A. 1928. Further studies on sex in asparagus. *Proc. Amer. Soc. Hort. Sci.* 25:13-16.
16. Tiedjens, V.A. 1924. Some physiological aspects of *Asparagus officinalis. Proc. Amer. Soc. Hort. Sci.* 21:129-140.

蘆筍理想性狀在育種上之利用

陳 榮 五

中文摘要

一般像蘆筍之類的長期作物，其育種時間都需要很長，利用其經濟特性做爲理想性狀，在育種上，育成品種的時間可縮短，又較容易去除不良的性狀。

蘆筍的理想性狀認定如下：

1. 母莖數，其與嫩莖數及產量有關。
2. 母莖高度，高大的植株，其產量較高。
3. 根盤大小，其與母莖數及產量有關，根盤愈大，生育愈旺盛，產量亦高。
4. 母莖第一分枝高度，其影響嫩莖筍尖之緊密度，其第一分枝高度愈高，筍尖愈緊密。
5. 母莖直徑，較大的母莖，雖可生產較大的嫩莖，但嫩莖較少，其產量較低。

本篇有關蘆筍理想性狀的訂定，其證明資料來自二個栽培品種的試驗及相關係數的研討。利用這些理想性狀在蘆筍育種上，育成了三個新的品種，即台南選一、二及三號。

1. 台灣省台東區農業改良場場長