

*Annals Of Agric. Sc., Moshtohor,*  
*Vol. 42(2): 729-735, (2004).*

**EFFECT OF LEAF-TYING AND SHADING ON HEADS QUALITY AND  
YIELD OF SUMMER CHINESE CABBAGE  
BY**

**Esmail, A.A.M.**

Central Laboratory for Agricultural Climate (CLAC) Agricultural Research  
Center, Ministry of Agriculture.

**ABSTRACT**

Two field experiments were carried out in El-Bossaily Protected Cultivations Unit, El-Behaire Governorate, Egypt in 2002 and 2003 seasons to study the response of some Chinese cabbage (*Brassica campestris* var. *pekinensis*) cultivars, i.e. China Queen, China Express and Tropical Delight to leaf-tying and shading as compared to the control (unshaded) in summer season. Data showed that leaf-tying significantly increased the head weight of both "China Queen and China Express" cultivars, but had a great positive effect on the heat-tolerant "Topical Delight". Yield increases were due to higher heading rate (number of plants with heads) and the development of heavier heads. Polyethylene net black covers had a positive effect on yield of all cultivars as compared to the unshaded (control). Vitamin C, total carotenoids and total sugars were increased due to leaf-tying and shading in all cultivars. An opposite trend was recorded for chlorophyll content as the lowest resulted from shaded head and the highest from the unshaded plants in the three cultivars. On the other hand, leaf-tying treatment increased total chlorophyll than the control heads in all cultivars.

**INTRODUCTION**

Chinese cabbage (*Brassica campestris* var. *pekinensis*) is a member of cruciferae Family. Optimum atmospheric temperature for head formation is about 15-16°C (Marukawa, 1975). Generally, Chinese cabbage can be grown successfully in temperate zones, highland and the Lowland of tropical regions. During the cool seasons the crop usually performs poorly when grown under high temperatures during the summer season of the tropical lowlands. Head formation of Chinese cabbage involves the orientation of the inner leaves of the plant with subsequent changes in the shape of the developing innermost leaves. At the initiation of head formation, the inner leaves form an enclosed structure with erect petioles and cupped leaf blades (Kato, 1981). High levels of light induces broadening of the leaves and formation of heads, while shading induces sagging of the outer leaves (Waters *et al.* 1992). This hyponastic movement is caused by low light intensity, the plant's age, auxin, and photoperiod (Ito and Kato, 1957; Kato, 1964 and 1966). Leaf-tying increased marketable yield when compared

with that of the unshaded control. When Chinese cabbage leaves are tied, shading for the newly developed inner leaves is provided and temperature is reduced about 5° C lower than the ambient temperature. This, in turn, stimulates head-filling and helps produce heavier marketable heads (Sajjapongse and Roan, 1983). In similar studies increasing shade levels tended to increase chlorophyll and carotenoids concentrations of tomato leaves (Moustafa, 1991 and EL-Gizawy *et al.*, 1992). Vitamin C content of mature tomato was decreased with reducing radiation (Venter, 1979).

The objective of the present study was to identify appropriate cultural management practices that might significantly enhance yield under Egyptian environment in the summer season.

### MATERIALS AND METHODS

Field experiments were conducted at EL-Bosaily protected Cultivation Unit, EL-Beheara Governorate during the two successive summer seasons of 2002 and 2003. Three Chinese cabbage cultivars were tested in both seasons Tropical Delight "heat resistant" recommended for summer planting and both China Queen and China Express moderately heat tolerant recommended for full planting. Treatments used in both seasons consisted of leaf-tying and polyethylene (PE) black net covers (light reduction factors 40% and 60%) as compared with the unshaded control.

The experimental soil was sandy in texture with pH 7.9 and E.C 3.1 mmhos. Soil chemical analysis showed that it contains 11.5 Mg, 12.75 Na, 11.5 Ca, 2.95 Hco<sub>3</sub>, and 13.45 Cl mg/L.

The experiments were arranged in a split-plot design with each cultivar forming a main plot, and leaf-tying and shading forming the subplots with three replicates. The size of each plot was 17.5m<sup>2</sup> and consisted of 5 rows. Each row was 5m long, 70cm wide and the spacing between plants was 40cm. Drip irrigation was applied and the agriculture practices took place whenever it was necessary according to the recommendations of Sajjapongse and Roan (1983).

Seeds in both seasons of 2002 and 2003 were sown in seedbed on 5<sup>th</sup> of Jun. Plants were transplanted in the field on 7<sup>th</sup> of July in the two seasons, respectively. All treatments were initiated 21 days after the transplanting. The leaf-tying treatment involved the loosely 6-8 outermost leaves which tied together with plastic cord to provide shade for the developing inner leaves. In another treatment, black P.E net covered the entire bed about 60 cm above the soil surface. Treatments were replicated 3 times in both 2002 and 2003 seasons. The temperature during the growing period ranged from 24° to 35° c in 2002 and 23° to 34° c in 2003. Ten heads were randomly chosen from each plot for the determination of marketable rate %, head weight g, heading rate %, ascorbic acid, total chlorophyll, total carotenoids and total sugars. Ascorbic acid was determined by using 2,6 dichlorophenolindophenol method as reported in A.O.A.C. (1980) and the results were calculated as mg/100g fresh weight. Total chlorophyll and total

carotenoids were determined as mg/100g fresh weight according to Robbelen method (1957). Total sugars were determined after Dubois *et al.*, (1956) and the results were calculated as g/100g weight.

**Statistical analysis:**

The physical and chemical results of this study were statistically analyzed using the analysis of variance method described by Snedecor (1956).

**RESULTS AND DISCUSSION**

Marketable yield, head weight and heading rate (number of plants with heads) of Chinese cabbage in both 2002 and 2003 seasons were increased by cultural management practices (Table 1). Leaf-tying increased marketable yield of China Queen, China Express and Tropical Delight by 42.1%, 40.21. and 48.0% during 2002 season and 43.9%, 42.4% and 50.5% during 2003 season, respectively as compared with that of the unshaded control. The use of black P.E. net improves the marketable yield of all cultivars during both 2002 and 2003 seasons as the increase ranged from 57.5% to 63.8% when compared with the unshaded control.

Head weight was affected by leaf-tying and different shading treatments (Table 1). All treatments showed significant effects on head weight. The maximum head weight of (2830g in 2002 season and 2930 in 2003 season) was recorded from the treatment of leaf-tying on Tropical Delight which was statistically different from the two other cultivars. Shaded plants produced significantly higher head weight than the unshaded plants. When Chinese cabbage leaves were tied, shading for the newly developed inner leaves was provided and temperature was reduced of about 3-5°C lower than the ambient temperature under 2002 and 2003 experiments conditions. Yield differences a raised from head weight and heading rate. Leaf-tying led to the highest average head weight of 2696.67 g and 2765.67 g in both seasons, respectively. Also, this treatment lead to the highest heading rate of 96.9% and 96.7% respectively.

The chemical composition of the heads, i.e. ascorbic acid, total carotenoids and total sugars were increased due to leaf-tying and shading, in all cultivars during the two cultivation seasons (Table 2). Data also indicated that Tropical Delight cultivar produced the highest ascorbic acid, total carotenoids and total sugars than China Queen and China Express. On the other hand, total chlorophyll content was decreased due to leaf-tying and shade in both cultivars of China Queen and China Express. An opposite trend was recorded for total chlorophyll heads in Tropical Delight cultivar when the use of leaf-tying increased this concentration of pigments. However, chlorophyll content of heads were decreased due to shade, as compared with the unshaded heads.

Table (1): Effect of leaf-tying and shading on marketable yield; head weight and heading rate of Chinese cabbage during summer season of 2002 and 2003 .

Cultivars	Treatments	2002 Season			2003 Season		
		Marketable yield (Kg./polt)	Head weight (g./head)	Heading rate %	Marketable yield (Kg./polt)	Head weight (g./head)	Heading rate %
China Queen F1	Leaf-tying	144.70	2650	91.00	151.60	2717	93.00
	P.E. net A	98.30	2210	74.07	104.80	2310	75.00
	P.E. net B	106.00	2227	78.20	111.80	2327	80.00
	Control	60.87	1820	55.10	66.50	1920	57.70
	Mean	102.47	2226.75	74.59	108.68	2318.50	76.43
China Express F1	Leaf-tying	140.90	2610	90.00	146.80	2710	90.30
	P.E. net A	96.40	2200	73.00	102.40	2300	74.20
	P.E. net B	103.00	2245	76.50	109.00	2178	77.50
	Control	56.70	1750	54.00	62.27	1843	56.97
	Mean	99.25	2201.25	73.38	105.12	2257.75	74.74
Tropical Delight F1	Leaf-tying	164.20	2830	96.70	170.40	2930	96.90
	P.E. net A	123.60	2405	84.10	129.30	2522	85.50
	P.E. net B	129.50	2500	86.20	134.20	2600	86.00
	Control	78.90	2153	62.20	86.03	2253	63.40
	Mean	124.05	2472.00	82.30	129.98	2576.25	82.95
L.S.D. at 5%	Cultivars	5.83	256.10	2.21	6.47	N.S.	1.31
	Cultivars X Treatments	11.95	233.70	2.48	11.97	348.70	4.24
Means	Leaf-tying	149.93	2696.67	92.57	156.27	2785.67	93.40
	P.E. net A	106.10	2271.67	77.06	112.17	2377.33	78.23
	P.E. net B	112.83	2324.00	80.30	118.33	2368.33	81.17
	Control	65.49	1907.67	57.10	71.60	2005.33	59.36
	L. S. D. at 5%	6.90	134.90	1.43	6.91	201.30	2.45

P.E. net A = Black polyethylene net cover ( light reduction factor 40%) - P.E. net B = Black polyethylene net cover ( light reduction factor 60%)

**Table (2): Effect of leaf-tying and shading on chemical composition of Chinese cabbage during summer seasons of 2002 and 2003.**

Cultivars	Treatments	2002 Season				2003 Season			
		V.C mg/100g f.w	T. chlorophyll mg/100g f.w	T. carotenoids mg/100g f.w	T. sugars g/100g d.w	V.C mg/100g f.w	T. chlorophyll mg/100g f.w	T. carotenoids mg/100g f.w	T. sugars g/100g d.w
China Queen F	Leaf-tying	50.00	39.00	35.50	27.90	53.00	40.70	36.80	27.83
	P.E. net A	44.00	34.50	29.20	25.80	48.00	35.50	29.70	26.90
	P.E. net B	42.00	35.60	29.00	26.50	45.00	35.90	30.00	26.40
	Control	29.00	45.00	13.00	15.70	32.00	45.40	13.00	16.60
	Mean	41.25	38.53	26.68	23.98	44.50	39.38	27.38	24.43
China Express F1	Leaf-tying	51.00	41.80	35.90	28.80	55.00	42.50	35.10	29.30
	P.E. net A	45.00	33.90	28.60	25.60	49.00	34.80	29.80	25.50
	P.E. net B	44.00	35.50	29.50	26.70	47.00	35.90	29.00	26.90
	Control	29.00	45.00	13.00	17.17	32.00	46.10	13.00	16.00
	Mean	42.25	39.05	26.75	24.57	45.75	39.83	26.73	24.43
Tropical Delight F1	Leaf-tying	65.00	50.60	42.30	30.70	71.00	50.40	37.70	31.60
	P.E. net A	55.00	41.30	34.90	27.80	59.00	42.60	34.50	27.50
	P.E. net B	53.67	42.70	34.50	28.30	58.00	43.90	33.80	28.90
	Control	38.33	47.00	15.00	20.40	42.00	48.50	16.00	21.20
	Mean	53.00	45.40	31.68	26.80	57.50	46.35	30.50	27.30
L.S.D.at 5%	Cultivars	8.02	1.35	0.70	1.07	4.43	0.27	1.94	1.67
	ultivars X reatments	6.42	3.54	4.53	3.52	6.81	4.20	3.76	3.45
Means	Leaf-tying	55.33	43.80	37.90	29.13	59.67	44.53	36.53	29.58
	P.E. net A	48.00	36.57	30.90	26.40	52.00	37.63	31.33	26.63
	P.E. net B	46.56	37.93	31.00	27.17	50.00	38.57	30.93	27.40
	Control	32.11	45.67	13.67	17.76	35.33	46.67	14.00	17.93
	L. S. D. at 5%	3.70	2.04	2.61	2.03	3.93	2.43	2.17	1.99

P.E. net A = Black polyethylene net cover ( light reduction factor 40%) - P.E. net B = Black polyethylene net cover ( light reduction factor 60%)

**CONCLUSION**

From the overall results it can be concluded that:

- Leaf-tying increased marketable yield of the 3 cultivars China Queen, China Express and Tropical Delight by 138%, 148.5% and 108% during 2002 season and 128%, 135.7% and 124% during 2003 season, respectively, compared with that of the control.

- The use of black P.E. net improves the marketable yield of all cultivars during both seasons by 50.4 to 75% as compared with the unshaded heads.
- All treatments showed significant effect on head weight and the maximum head weight was recorded from leaf-tying on Tropical Delight cultivar.
- Ascorbic acid, total carotenoids and total sugars were increased due to leaf-tying and shading as compared to the unshaded plants.
- Total chlorophyll content of head was decreased due to leaf-tying and shading as compared to the head of control plants in both cultivars of China Queen and China Express.
- Total chlorophyll content in head of Tropical Delight cultivar was increased due to leaf-tying, while this content was decreased by shading.

### REFERENCES

- A.O.A.C. (1980): Official methods of analysis. The A.O.A.C., 13th Ed. Association of Official Analytical Chemistry, Washington, D.C. U.S.A.
- Dubois, M.; Gilles, K.A.; Hailton, J.K.; Rebers, P.A. and Smith, F. (1956): Colorimetric method for determination of sugars and related substances. *Analytical Chemistry*, 28:350-356.
- EL-Gizawy, A.M.; Abdallah, M.M.F.; Gomaa, H.M. and Mohamed, S.S. (1992): Effect of different shading levels on tomato plants. 2. Yield and fruit quality. *Acta Hort* 323; 349-353.
- Ito, H. and Kato, T. (1957): Study on the head formation of Chinese cabbage: histological and physiological studies of head formation. *Japan. Soc Hort.Sci.* 26:154-162.
- Kato, T. (1964): Studies on the head formation of Chinese cabbage: III. Physiological studies on the earliness of head formation. *Res.Rpt.Kochi Univ. Nat Sci II* 13: 205-210.
- Kato, T. (1966): Studies on the head formation of Chinese cabbage: V. Effects of environmental factors on the nastic movement of leaves. *Res. Rpt.Kochi Univ.Nat.Sci. II* 15: 149-157.
- Kato, T. (1981): The physiological mechanism of heading in Chinese cabbage, P. 207-215. In: N.S.Talekar and T.D. Griggs (eds.) *Proc. 1st Intern. Symp Chinese cabbage. The Asian Vegetable Research and Development Center, Shan hua, Tainan 741, Taiwan, R.O.C.*
- Marukawa, S. (1975): Chinese cabbage culture in Japan. *Farming Japan* 9: 28-37.
- Moustafa, S.M.S. (1991): Effect of shading on growth, yield and fruit quality of tomato plant. M.Sc. Thesis, Fac. Agric. Ain Shams Univ., Cairo, Egypt.
- Robbelen, G. (1957): Quantitative analysis of chloroplast pigments. *Untersuchungen an strahlenin du Zier ten blatter-bumtanten Von Arabidopsis Thaliana (L) vere bung I ehre*, 88:189.
- Sajjapongse, A. and Roan, Y.C. (1983): Effect of shading and leaf tying on summer chinese cabbage. *Hort. Scince*, 18: 464-465.
- Snedecor, G. W. (1956): *Statistical Methods*. 5<sup>th</sup> Ed. The Iowa state Univ. Press. Amer., Iowa, U.S.A.
- Venter, F. (1979): Solar radiation and vitamin C content of tomato fruits. *Acta Hort*. 58:121-126.

Waters, C. T.; Morgan, W. C. and Mc Geary, D.J. (1992): How to identify, grow and use oriental vegetable, Melbourne, Agmedia PP 128.

تأثير التظليل وربط الأوراق على جودة الرؤوس ومحصول الكرنب الصيني

عبد المنعم أحمد محمد إسماعيل

المعمل المركزي للمناخ الزراعي، مركز البحوث الزراعية، وزارة الزراعة.

أجريت التجربة خلال الموسم الصيفي لعامي ٢٠٠٢-٢٠٠٣ بمزرعة وحدة البوصيلي للزراعة المحمية بمحافظة البحيرة. وذلك لدراسة استجابة بعض أصناف الكرنب الصيني تشينا كوين، تشينا اكسبريس، تروبيكال ديليت لمعاملات التظليل باستخدام شبك يقلل الضوء بنسبة ٤٠٪ و ٦٠٪ وربط الأوراق الخارجية للرؤوس ومقارنتها بالنباتات المنزرعة بدون معاملة.

وقد أظهرت النتائج أن ربط الأوراق الخارجية أدى إلى زيادة معنوية في وزن الرؤوس لكل من الصنف تشينا كوين والصنف تشينا اكسبريس، وكان التفوق واضحاً في الصنف تروبيكال ديليت حيث انه صنف يتحمل الحرارة المرتفعة في حين أن كلا الصنفين الأولين يناسبهما درجة الحرارة المنخفضة. وتعزى الزيادة في المحصول إلى زيادة نسبة النباتات المكونة للرؤوس بالإضافة إلى جودة الرؤوس المتكونة. وقد تأثر محصول الأصناف المختلفة تأثيراً إيجابياً بمعاملة التظليل بشبك البولي ايثيلين مقارنتاً بنباتات المعاملة الكنترول. وتفاوتت معاملة ربط الأوراق الخارجية على معاملة التظليل لكل الأصناف. وقد زاد محتوى الرؤوس من حمض الأسكوربيك والكاروتينات الكلية والسكريات الكلية نتيجة لمعاملات ربط الأوراق الخارجية والتظليل. في حين قل محتوى الرؤوس من الكلوروفيلات الكلية نتيجة لتظليل النباتات، وزاد في النباتات التي تم تربيطها.