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EFFECTS OF SEEDING METHOD, SPACING AND FERTILIZER ON CHINESE KALE

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SUMMARY

Two seeding methods, three spacings within 30 cm row and three forms of fertilizer were investigated on Chinese kale ('Kai Lan') in a factorial experiment. Transplanting at 2 weeks after sowing resulted in more vigorous plant growth and higher marketable fresh-weight yield with greater mineral content than direct seeding. Decreasing plant spacing within the row from 30 cm to 20 cm and 10 cm resulted in a progressive increase in fresh-weight yield per hectare, due mainly to a greater number of plants per hectare. A combination of cowdung and inorganic fertilizer was superior to inorganic fertilizer alone which in turn was superior to a commercial organic-inorganic fertilizer mixuture.

'Kai Lan' or Chinese kale *(Brassica alboglabra* Bailey) is a popular green leafy vegetable in this country. It contains high calcium and iron and also Vitamin A precursor (Herklots, 1972). In comparison with other green leafy vegetables, it fetches one of the highest prices in the local markets. Kai Lan' is mainly cultivated on limited scale by local farmers and practically no experimental work has been carried out on the crop.

The purpose of this present work was to study the effects of different seeding methods, spacings within the row and forms of fertilizer on the growth, marketable yield and quality of the 'Kai Lan' crop.

MATERIALS AND METHODS

The experiment was conducted during July-September, 1973, on loamy-sand soil in the Faculty field area. The investigation was carried out in a 2 x 3 x 3 factorial experiment, with treatment combinations arranged in randomized complete blocks and replicated four times. Factors investigated were:

Seeding Method:

S_1 : Direct Seeding
S_2 : Transplanting

Spacing within 30 cm row:

D_1 : 30 cm (111, 111 plants/ha)
D_2 : 20 cm (166, 667 plants/ha)
D_3 : 10 cm (333, 333 plants/ha)

Forms of Fertilizer (supplying 67 kg N/ha):

F_1 : 1900 kg/ha of a commercially available organic-inorganic fertilizer mixture (3.5% N, 8.1% P_2O_5, 3.2% K_2O).
F_2 : 1000 kg/ha well-rotted cowdung (1.0%N) plus 380 kg/ha inorganic fertilizer (15% N, 15% P_2O_5, 15% K_2O).
F_3 : 447 kg/ha inorganic fertilizer (15% N, 15% P_2O_5, 15% K_2O).

Individual plots consisted of a raised beds 240 cm long and 120 cm wide. Each plot received a basal dressing of the appropriate fertilizers 1 week prior to sowing of seeds. The fertilizers were applied in shallow furrows in between planting rows and covered with soil.

Seeds of a 'Taiwan' cultivar were sown on the same day for both the direct-seeding and transplanting treatments. The seeds for direct seeding were sown in the field, in rows 30 cm apart and with three rows per bed. Ten days after sowing the first thinning was carried out, followed by a second thinning 4 days later to appropriate spacing between plants in the row. For transplanting, the seeds were first germinated in nursery pots containing germinating medium. Two weeks after sowing the seedlings were transplanted to the field at the appropriate spacing between plants in three 30–cm rows per bed.

Samplings of plants for growth analysis began on the 3rd week after sowing (1 week after transplanting) and continued at weekly intervals for 6 weeks. Each sample consisted of three plants taken at random from the outer two plant rows in each plot. Leaf number, leaf-blade area and total dry matter per plant were determined on each sampling period. Leaf-blade area was determined by dry-weight disc method. The area/dry-weight relationship was determined for each sampling by weighing dried discs of known area from subsamples. Dry matter of plants was determined after drying for 48 hr in an electric oven maintained at 70°C.

On the 8th week from sowing, plants in the middle row of each plot were harvested for determination of marketable fresh-weight yield. The moisture, crude-fibre and mineral contents of the harvested plants were also determined as an indication of quality of products.

RESULTS

Growth

Seeding method markedly affected plant growth (Fig. 1). Transplants (S_2) produced a higher leaf number, leaf area and total dry matter than direct-seeded plants (S_1) throughout the sampling period. A significant difference in leaf number per plant between S_1 and S_2 was obtained only at 8 weeks after sowing. Significant differences in Leaf Area Index (L.A.I.) between S_1 and S_2 occurred at 5,6 and 7 weeks after sowing, while significant differences in dry-matter accumulation occurred almost throughout the sampling period.

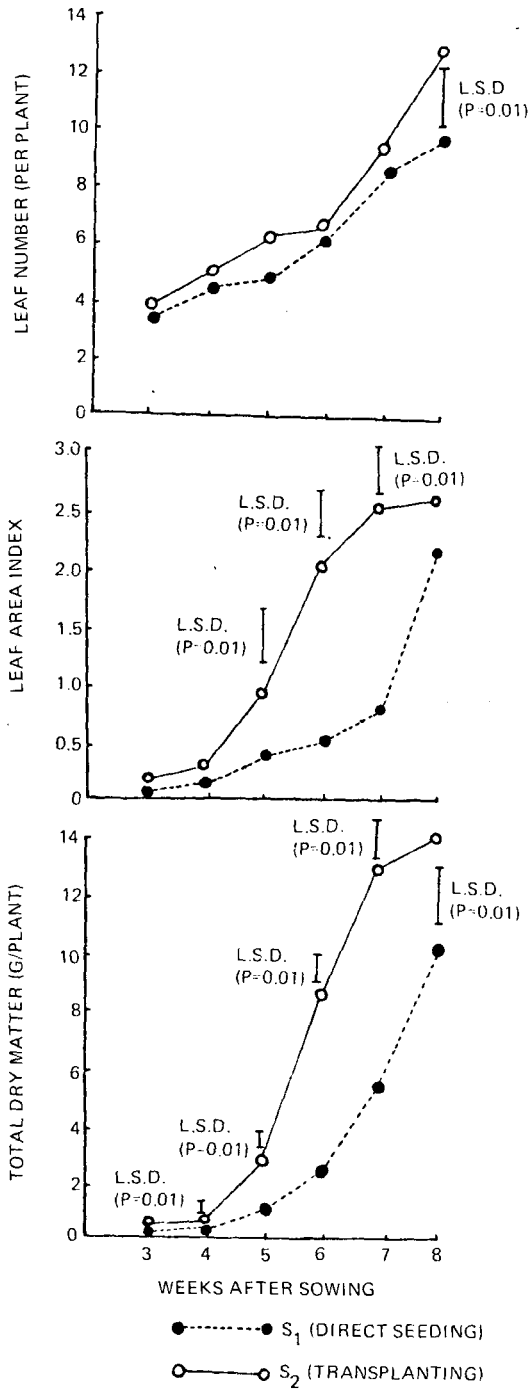

FIG. 1. *Effect of seeding method on leaf number, leaf area index and total dry matter.*

Figure 2 shows the changes in mean relative growth rate (R.G.R.) and mean net assimilation rate (N.A.R.) with time for the two seeding methods. For both seeding methods, maximum R.G.R. was attained at the interval 4-5 weeks after sowing, after which the growth rate declined progressively. At 4-5 weeks and 5-6 weeks after sowing, the mean R.G.R. of S_2 was significantly greater than that of S_1, but at 6-7 weeks and 7-8 weeks after sowing the situation was reversed. Similar pattern was shown by the mean N.A.R. This result from growth analysis suggested that the greater R.G.R. of S_2 during the 4-6 weeks interval could be due to the higher photosynthetic efficiency of the leaf (estimated as N.A.R.). However, due to the greater leaf area development with time, which could have resulted in increased mutual shading of the lower leaves, the photosynthetic efficiency of the leaf dropped rapidly. This would explain the rapid decline of R.G.R. of S_2 during the 6-8 weeks interval. The lower leaf area development of S_1 and the consequent less severe mutual shading led to the less rapid drop in photosynthetic efficiency of the leaf and therefore the maintenance of R.G.R. above that of S_2 at 6-8 weeks.

Spacing did not produce a significant effect on leaf number and dry-matter accumulation but it significantly affected L.A.I. The L.A.I. increased with decreasing spacing between plants in the row (Fig. 3). The L.A.I. of D_3 (10 cm) was significantly greater than those of D_2 (20 cm) and D_1 (30 cm) at 5,6,7 and 8 weeks after sowing, whereas the L.A.I. of D_2 was significantly greater than that of D_1 at 7 and 8 weeks.

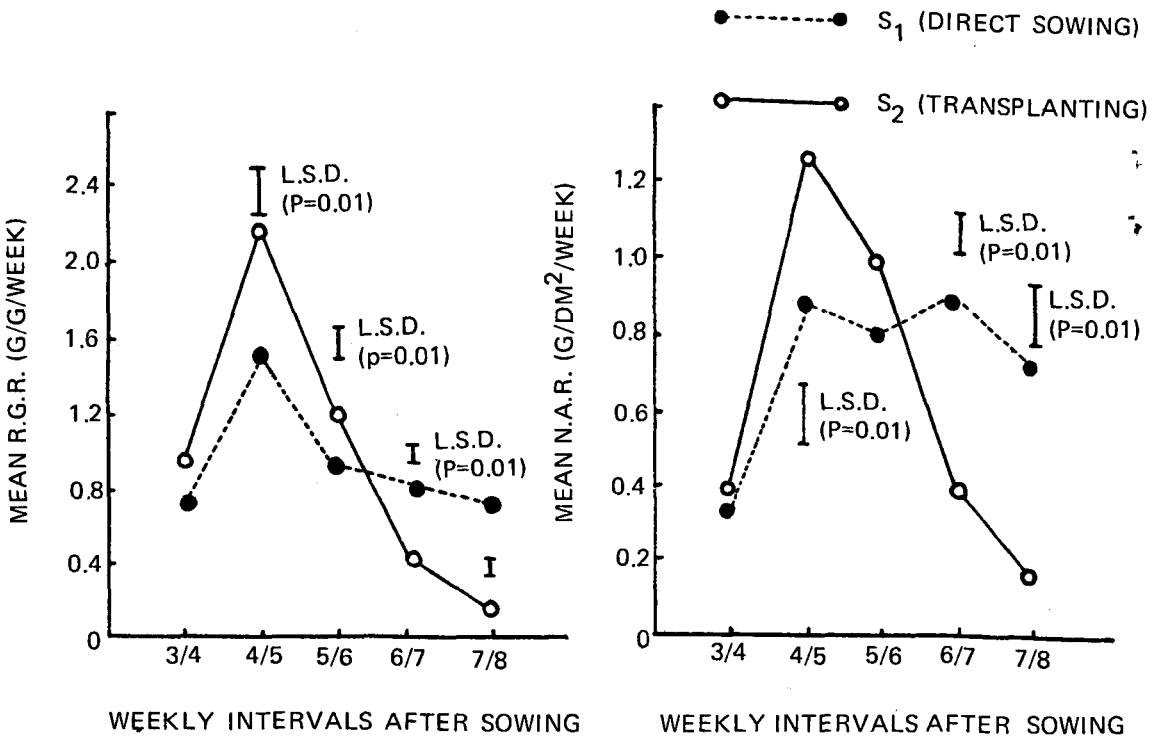

FIG. 2. *Effect of seeding method on mean relative growth rate (R.G.R.) and net assimilation rate (N.A.R.).*

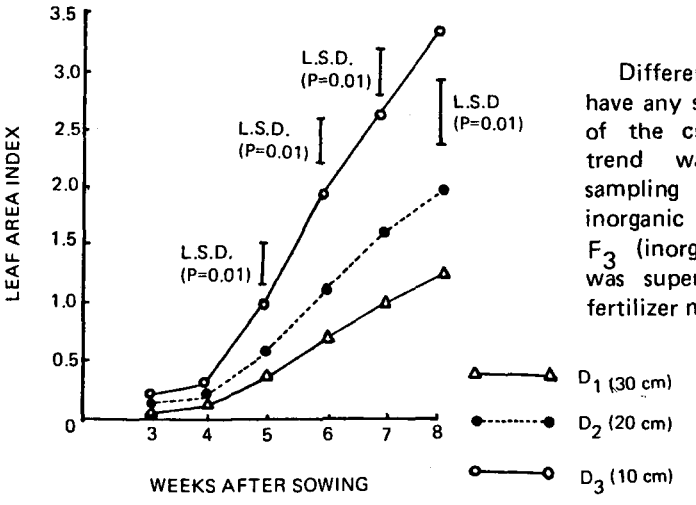

FIG. 3. *Effect of spacing within 30-cm row on leaf area index.*

Different forms of fertilizer did not have any significant effect on the growth of the crop. However, a consistent trend was shown throughout the sampling period with F_2 (cowdung + inorganic fertilizer) being superior to F_3 (inorganic fertilizer) which in turn was superior to F_1 (organic-inorganic fertilizer mixture) (Fig. 4).

Table 1. *Effect of seeding method, spacing and fertilizer on mean fresh-weight yield and quality of 'Kai Lan' harvested at 8 weeks after sowing.*

Treatment	Fresh-weight yield/plant (g)	Fresh-weight yield/ha (kg)	Moisture (%)	Crude-fibre (%)	Mineral Content (%) H	P	K	Mg	Ca	Na
SEEDING METHOD										
S_1*	68.37a**	13,619a	85.40a	6.67a	4.26a	1.69a	5.21a	0.48a	3.65a	0.27a
S_2	105.26b	20,853b	86.10a	8.00b	4.66a	1.88b	5.33a	0.68b	4.24b	0.29a
S.E. of Means($\pm$)	4.12	1,069	n.a.	0.032	1.09	0.032	0.035	0.003	0.024	0.010
SPACING WITHIN ROW										
D_1	87.20a	9,689a	84.60a	7.42b	4.34a	1.81a	5.30b	0.58b	3.90a	0.27a
D_2	94.35a	15,725b	84.90a	7.36b	4.43a	1.82a	5.37b	0.61c	4.08b	0.34b
D_3	78.88a	26,295c	85.20a	7.22a	4.61a	1.73a	5.14a	0.54a	3.87a	0.24a
S.E. of Means($\pm$)	5.05	1,309	n.a.	0.039	1.34	0.039	0.043	0.004	0.028	0.014
FORMS OF FERTILIZER										
F_1	77.05a	15,379a	84.90a	7.26a	4.37a	1.77a	4.93a	0.57a	4.04b	0.26a
F_2	91.73a	18,303a	84.10a	7.37a	4.41a	1.78a	5.55c	0.57a	3.90a	0.36b
F_3	91.65a	18,026a	84.80a	7.37a	4.59a	1.81a	5.32b	0.59b	3.91a	0.23a
S.E. of Means($\pm$)	5.05	1,309	n.a.	0.039	1.34	0.039	0.043	0.004	0.028	0.014

*Refer to Materials and Methods for interpretation of symbols S_1, S_2 etc.

**Values within a column for each treatment followed by the same letter are not significantly different at 1% probability based on Duncan's multiple range test.

n.a. = not available.

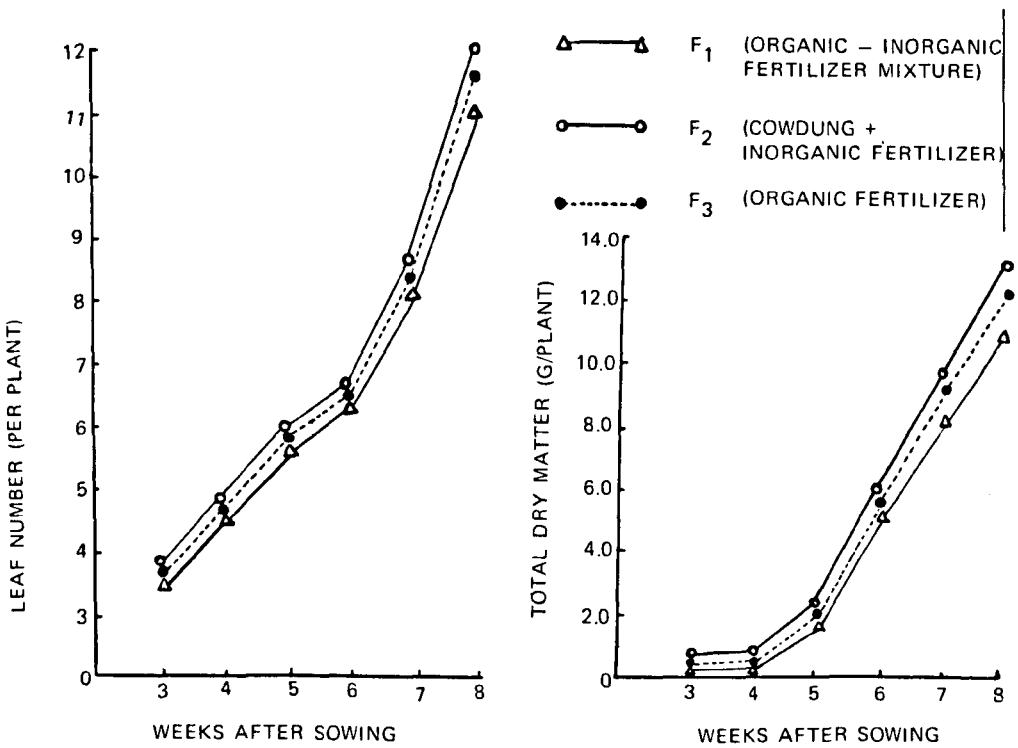

FIG. 4. *Effect of forms of fertilizer on leaf number and total dry matter*

Fresh-weight yield and quality

The data summarized in Table 1 show the effect of treatments of fresh-weight yield and quality of crops harvested at 8 weeks after sowing.

Seeding method gave a highly significant effect on the fresh-weight yield and some quality of the product. Transplanted plants (S_2) yielded significantly higher fresh weight per plant and per hectare than direct-seeded plants (S_1). Moisture content between the two seeding methods was not significantly different. However, crude-fibre and most mineral contents were significantly higher in S_2 than in S_1. Therefore, it can be seen that both yield and quality of transplants were superior to those of direct-seeded plants. Although crude-fibre content of the transplants was higher than that of direct-seeded plants the value (8.0%) is still within acceptable range of marketable quality, as an earlier analysis of a market sample of this vegetable gave a crude-fibre value of 7.2%.

Spacing did not affect fresh-weight yield of individual plants but it significantly affected yield per hectare (Table 1). Decreasing the spacing within the row from 30 cm (D_1) to 20 cm (D_2) and 10 cm (D_3) resulted in a progressive increase in fresh-weight yield per hectare. Moisture content was not significantly different among the three spacings. Crude-fibre and most mineral contents were, however, significantly lower in D_3 than in D_2 or D_1.

Different forms of fertilizer did not significantly affect fresh-weight yield, although yield of F_2 (cowdung + inorganic fertilizer) and F_3 (inorganic fertilizer) tended to be superior to that of F_1 (organic-inorganic fertilizer mixture). Moisture and crude-fibre contents of plants were not significantly different among the three fertilizer treatments, though some variation in mineral content was obtained. Except for calcium, most of the

minerals of plants treated with F_1 were low compared with those treated with F_2 or F_3. The high calcium accumulation in plants treated with F_1 is mainly due to the larger amount of this mineral in the fertilizer.

DISCUSSION

The present study showed that transplants, when harvested at 6 weeks after transplanting (8 weeks after sowing), yielded about 53% more marketable fresh-weight with higher mineral content than direct-seeded plants of the same age. The higher yield of transplants was attributed mainly to greater dry-matter accumulation and the production of more leaves and larger leaf-blades. From the growth analysis, it appears that the superiority of transplants is the result of greater relative growth rate attained during the 2-4 weeks period after transplanting (4-6 weeks after sowing) which may have led to earlier maturity of the transplanted crops. The results from this study contradict the findings reported on cabbage where earlier and better crops have been obtained with direct-seeded plants as they received no check in growth (Nieuwhof, 1969; Al'tergot; Mordkovic, 1970; Shumaker, 1970). Such a contradiction in results is probably due to differences in crop species and also in field conditions. The advantage of transplanting in the present study is probably due to the breakage of roots during the operation and their subsequent rapid replacement by new ones. This probably resulted in greater root branching and hence, greater absorbing surface, mineral uptake and plant growth than when the plants were allowed to grow *in situ*.

Under local growing conditions, it is thus reasonable to conclude that 'Kai Lan' crop is best grown as transplants. In addition to greater yield and better quality obtained from the seeding method there is a further advantage, as the land which the crop is to occupy can meanwhile be producing some previously planted vegetable. To sow seeds directly in the field can be expensive especially when thinning is required. Moreover, it takes more seeds to plant a unit area.

Close spacing has often been recommended for Brassica crops intended for fresh consumption (Bantoc, 1967; Nieuwhof, 1969; Martindale, 1973). In the present study, decreasing the spacings in the row led to a progressive increase in fresh-weight yield per hectare The yield per hectare was increased by 62% and 171% when spacing in the row was reduced from 30 cm to 20 cm and 10 cm, respectively. This increase in yield with closer spacing is due mainly to the greater number of plants per hectare. The greater plant number also explains the lower mineral content of the plants at the closest spacing (10 cm) compared to the two wider spacings of 20 cm and 30 cm, as there was greater competition for nutrients.

The association of late maturity with closer spacing has been reported on cabbage by Nieuwhof (1969). In the present study, the plants at the closest spacing (10 cm) contained the lowest crude-fibre content. This may be associated with the stage of maturity of the plants as they could be slower in maturity due to more mutual shading as indicated by the high L.A.I. value.

Although no significant effects on growth and yield were obtained by using different forms of fertilizer, there was a consistent trend showing the superiority of the combination of cowdung and inorganic fertilizer over inorganic fertilizer alone. Superiority of the combination of organic manure or compost and inorganic fertilizer over inorganic fertilizer alone in affecting yield have also been reported by Bantoc (1967) on non-heading pechay (*Brassica chinensis* Jus.) and by Nieuwhof (1969) on cabbage (*Brassica oleracea* L. var. *capitata* L.). The advantage of the combination has been explained by the importance of organic manure in improving the soil structure, thus,

increasing the effect of the inorganic fertilizer. The poor performance obtained in this study with a commercially available organic-inorganic fertilizer mixture may be expected as the mixture contained about 45% organic constituent. The nutrients from such a high proportion of organic component may not be readily available to a fast maturing crop like 'Kai Lan' which has its maximum growth rate at 4-5 weeks after sowing (2-3 weeks after transplanting).

RINGKASAN

Dua cara pembenihan, tiga penjarakan diantara baris sebesar 30 cm dan tiga bentuk dari baja telah diselidiki pada kubis daun Cina ('Kai Lan') dalam percobaan faktorial. Pemindahan 2 minggu setelah penyemaian menyebabkan pertumbuhan tanaman lebih cepat dan pemasaran hasil berat basah lebih baik dengan kandungan mineral daripada pembenihan langsung. Penyempitan jarak tanaman diantara baris dari 30 cm ke 20 cm dan 10 cm menyebabkan penambahan bertahap dalam hasil berat basah per ekar, terutama disebabkan bertambahnya jumlah tanaman per ekar. Gabungan dari tahi sapi dan baja inorganik mengungguli campuran baja organik-inorganik dagangan.

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