Table 1. Effect of film mulch and soil fumigation on multiple cropping yields of bell pepper and squash.

Treatment	Yield (metric tons/ha) Peppers	Squash	Total of both crops
film mulch + soil fumigant	53.7 ab[z]	63.9 a	117.6 a
film mulch	61.7 a	50.6 ab	112.3 ab
soil fumigant	49.5 bc	43.9 b	93.4 b
control	43.0 c	26.0 c	69.0 c

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

superiority of the film mulch treatment.

Soil samples indicated that the nematode populations were comprised almost exclusively of the root-knot nematode with only occasional instances of *Criconemoides ornatus* Raski, *Helicotylenchus dihystera* (Cobb) Sher, and *Trichodorus christiei* Allen. The root-gall indices recorded early in the second crop reflected the general build-up of the nematode populations during the pepper crop, a species which under normal conditions is not severely parasitized by *M. incognita*. Yield of summer squash, a preferred host for root-knot nematodes, was significantly reduced by invasion of this parasite (Fig. 1). Final yield, as a consequence, was negatively correlated (r = –.87) with the root-gall index taken early in the growth of the squash crop. Film mulch with soil fumigation most successfully minimized reinfestation. Film mulch alone, if the initial nematode populations are low, has been shown in other studies (5) to inhance plant growth and increase yield, subsequently masking the effects of nematode damage. This would in part account for the relatively high yield response to mulch in the second crop. The degree of

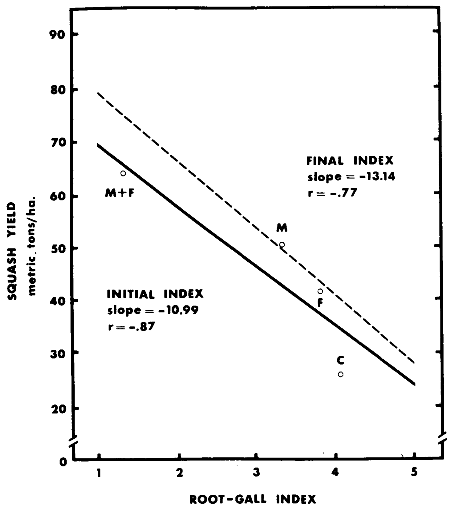

Fig. 1. Linear regression between root-gall indices recorded 16 days after seeding and at the termination of the squash crop and final squash yield. Points represent means of the initial index for film mulch + soil fumigation (M + F), film mulch (M), soil fumigation (F), and control (C).

correlation (Fig. 1) between root-gall indices recorded at the end of the production period and final yield was lower (r = –.77) and had shifted toward a higher nematode population level in comparison to the regression equation between the root-gall index taken at the beginning of the squash crop and final yield. This indicates that although the nematode populations were lower in the better treatments, the populations in all treatments increased toward the end of the second crop. Therefore, nematode populations could pose a limiting factor in the potential for production of three crops in succession.

The ability to spread fixed costs over 2 or more crops in succession greatly enhances the feasibility of the low unit cost – high level of production concept for many vegetables. While the potential to continually apply low levels of fertilizer through the trickle lines is a vital component in the feasibility of multiple cropping, the need for the integration of this potential into a complete production system is apparent. Total combined yield of both crops was highest with film mulch plus soil fumigation, followed by film mulch, soil fumigation and control (Table 1). These results indicate that multiple cropping with trickle irrigation under south Georgia conditions has the potential to increase the profit derived per hectare provided nematode populations can be maintained at a low level. Additional research is needed to moniter the buildup of nematodes and soil-borne plant pathogens in various crop sequences and establish possible control measures.

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Strip Cultivation of the Area Wetted by Drip Irrigation in the Arava Desert[1]

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Additional index words. corn, *Zea mays*

Abstract. **Corn (*Zea mays* L.) grown in the Arava desert of Israel developed more rapidly and produced a higher yield when planted in soil strips which had previously been used for drip-irrigated melons, than when grown in the spaces between strips. Leaching with sprinklers before planting had no effect on the corn grown on the previously drip-irrigated strips, but did significantly effect plant weight and weight of Grade A ears in the area between the previously cultivated strips. Plantings which diagonally intersected the drip-irrigated strips and the spaces between resulted in uneven growth, with better development where the strips were intercepted.**

Within cultivated areas of the Arava desert in Israel there is considerable variation of crop growth and yield (3). Non-uniform soil structure and varying concn of minerals at different depths, even over short distances are responsible (4). These variations are not stable and may be partly due to soil movement by cultivation, or to other cultural practices (3).

The main crops are drip-irrigated, consequently water and fertilizer applications are limited to the irrigated strip through most of the growing season. In a number of studies calculations were made to characterize the nature of water distribution from low-discharge point or line sources (1, 2, 5, 6). Between treated strips, the soil surface remains dry and salts accumulate at the wetting front. Compaction due to workers and implement movement also occurs in this space.

The purpose of the present work was to clarify these points: a) The possible relation between non-uniform growth of crops and the fact that the previous crop had been drip-irrigated in strips; b) The significance of drip-irrigated strips or spaces between them for the following crop; c) The salt distribution pattern after a drip irrigation season, and the possibility for continued crop cultivation without the need of leaching with sprinkle irrigation.

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An experiment was conducted at Yotvata, on a field consisting of sand to sandy-loam soil of very low clay content. The cec varied from 3-6 meq/100 g soil. Between Aug. to Dec. 1970, a crop of melons was grown and drip-irrigated (2-liters/hr emitters, 0.5 m apart). Before seeding, manure (40 m^3/ha) was applied and the field was leached by sprinkling. Water containing 530 mg Cl/liter, 14.0 meq Na/liter and 24.2 meq Ca + Mg/liter, with an ec of 3.2 mmhos/cm was used.

Following the melon crop, the drip-irrigated strips and spaces between were carefully marked, and planted to 'Neveh Yaar 65' corn on Feb. 8, 1971. Four replicated plantings were made exactly on the previously-cultivated strips; and exactly on the space between. A non-replicated treatment of diagonal rows which alternately intersected the cultivated strips of the previous crop and the spaces between them was also included. Also, two 5-m wide strips perpendicular to the crop rows in all treatments were leached by sprinkling with 200 mm of water.

Drip laterals were located between a pair of crop rows. Germination was brought about by drip irrigation alone. Irrigation frequency during the cool season was every 2 days and daily thereafter. Water quantity applied was based on 80% of the evaporation from a Class A pan. Fertilization was consistent with local practice.

Soil sampling for ec and ion content determination was carried out at the end of the melon season, and after leaching the perpendicular strips at the beginning of the corn crop. Length, width and dry wt of 2 leaves from each of 10 plants in each replication was determined. Fresh wt of 4 plants collected at random from each plot was recorded on May 18. Ear number and wt was recorded on May 24 and June 3.

Vegetative development was more rapid on the previously cultivated strips than on the spaces (Table 1), resulting in earlier yield and significantly higher total ear wt and wt and no. of Grade A ears (Table 2).

Table 1. Development of corn grown on previously drip-irrigated strips or on the spaces between them.

Factor	Previous drip-irrigated strips	Previous non-irrigated spaces	t-value
Leaf length (cm)	61.2	56.5	2.67*
Leaf width (cm)	7.7	7.2	2.77*
Leaf dry wt (g)	11.7	11.1	2.25*
Fresh wt of 4 plants (kg)	2.3	1.6	4.36**

*, ** Significant at the 5% and 1% probability levels, respectively.

Soil tests showed the salinity level at a depth of 5-45-cm below the drip lateral was quite low, and equal to that achieved by efficient leaching (Table 3). In the 0-5-cm layer the values were considerably higher. Results were similar in the area between the crop rows.

The effect of sprinkler leaching on plant performance is shown in Table 4. When seeded on the previously drip-irrigated strips, there was no difference between the leached and the non-leached areas. In plantings between strips, leaching had a significant effect on plant wt and on wt of Grade A ears. Effects on total yield were insignificant. One week after drip-irrigation began, tests showed that leaching had not differentially affected soil salinity.

In the diagonal rows which alternately intersected the drip-irrigated strips and the spaces between them, growth was undulating. Plants were more developed where the row crosses a strip, and less developed in the spaces.

In the present study, the cumulative effect of factors influencing the drip-irrigated strip such as manuring, pre-plant tillage, irrigation, fertilization, plant cover, and leaching was studied without attempting to isolate any one. After fall melons, better corn was produced when planted on the strips where the melons previously grew than in the spaces between. Continued cropping on the drip-irrigated strip creates a number of technical problems, and demands separate study.

Except for the 2 perpendicular strips, the entire field was not leached prior to planting the corn as the salinity level was low, especially in the zone previously occupied by the melon roots where it was expected that the corn roots would also be located. Salinity

Table 2. Yield of corn grown on previously drip-irrigated strips or on the spaces between them (per 12 m row).

Factor	Treatment	First harvest	Second harvest	Total
Total ear wt (kg)	Strips	29.7	12.7	42.4
	Spaces	9.1	9.8	18.9
	t-value	4.00**	0.82	3.88**
Wt of Grade A ears (kg)	Strips	20.7	2.2	22.9
	Spaces	8.3	1.2	9.5
	t-value	5.66**	0.74	4.67**
No. of Grade A ears	Strips	76.3	6.8	83.1
	Spaces	38.0	7.0	45.0
	t-value	4.10**	0.05	3.47*

*, ** Significant t-test at the 5% and 1% probability levels, respectively.

Table 3. Soil analysis (1:1 soil-water extract) following melon crop (Dec. 21, 1970).

Sampling location	Soil depth (cm)	E.C. (mmhos/cm)	Cl (meq/L)	Na (meq/L)	NO_3 (meq/L)
Drip-irrigated melon row	0-5	3.52a	10.50a	9.10a	130.0a
	15	0.74b	1.92b	2.54b	28.3b
	30	0.69b	2.20b	2.69b	31.7b
	45	0.60b	1.72b	2.38b	25.0b
Between melon rows	0-5	5.08a	19.50a	12.00a	98.1a
	15	0.82b	1.37b	2.02b	20.0b
	30	0.63b	1.30b	2.38b	33.4b
	45	0.72b	1.87b	3.35b	33.4b

Within each sampling location, values followed by the same letter are not significantly different (P = 5%) according to the F and range tests.
Between sampling locations, the differences are significant for all the parameters only at the 0-5-cm soil depth (t-test, P = 5%).

Table 4. Sprinkler leaching effect on corn plants growing on the previously drip-irrigated strips or on the spaces between them.

Factor	Previously drip-irrigated strips		Previously non-irrigated spaces	
	Leached	Not Leached	Leached	Not leached
Wt of 4 complete plants cut at soil level at end of season (kg)	2.4	2.3	1.8	1.4
Significance	ns		*	
Wt of Grade A ears from the 4 plants (kg)	4.43	3.45	3.00	1.90
Significance	ns		**	

*, ** Significant t-test at the 5% and 10% probability levels, respectively. ns = not significant.

data from the previously drip-irrigated strip (Table 3) show that the salinity level did not exceed that which was obtained after leaching by sprinkling (Table 5), except in the 0-5 cm layer where the problem of salinity increases following drip-irrigation. Although leaching of the strips was not advantageous, leaching of the spaces significantly increased plant growth and yield. Thus, after a fall melon crop, leaching may be desirable, particularly in the area between the cultivated strips.

Salt accumulation distant from the drip lateral is problematic, regarding total concn and relative concn of the various ions. In this regard, these points are important: water obtained from the Yotvata pipeline contained at least 14 meq Na/liter, and due to the nature of water distribution by the drip method and duration of irrigation, the distance of ion movement will differ from season to season, and the relative concn of the ions will also differ over this distance. This aspect is important where evaporation and salt accumulation is high. Preliminary results show the SAR in the 0-5 cm layer increases with distance from the emitter, due to an increase of Na in relation to Ca + Mg (Table 6). This condition is liable to cause dispersion of soil aggregates and to seal the upper soil layer. It is possible that these factors were partly responsible for the poor results obtained in the spaces compared to the strips.

The problem of sanitation may arise if crops are repeatedly located on the same strip, especially if they are the same or closely-related crop. This aspect is also being examined in a separate experiment.

Table 5. Soil analysis (1:1 soil-water extract) in the 2 perpendicular strips after being leached by sprinkling with 200 mm of water and prior to seeding of the corn.

Sampling location	Soil depth (cm)	E.C. (mmhos/cm)	Cl (meq/L)	Na (meq/L)
In the previously drip-irrigated strip	0-5	1.96	7.5	7.8
	15	1.39	4.6	5.2
	30	1.54	5.2	5.5
	45	1.75	5.9	6.9
In the previously non-irrigated spaces	0-5	1.98	4.7	5.5
	15	2.62	6.2	8.8
	30	1.99	4.1	6.0
	45	1.63	4.1	5.7

Table 6. Soil analysis (1:1 soil-water extract) following harvest of the drip-irrigated corn crop.

Sampling location	Soil depth (cm)	E.C. (mmhos/cm)	Cl (meq/liter)	Na (meq/liter)	Ca+Mg (meq/liter)	SAR
In the corn rows	0-5	2.39	5.7	7.6	30.7	1.93
	15	1.18	5.0	5.9	27.6	1.70
	30	1.06	4.6	5.2	7.7	2.86
	45	1.08	4.4	5.0	7.4	2.72
Between the corn rows	0-5	29.60	382	200	196	22.00
	15	4.40	21.9	21.6	48.4	4.39
	30	3.88	15.8	14.0	41.5	3.09
	45	3.77	13.8	14.7	41.1	3.22

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Fumigation of Soil Strips through a Drip Irrigation System[1]

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Additional index words. tomato, *Lycopersicon esculentum*, methyl bromide, broomrape, *Orbanche* spp.

Abstract. **In the Arava desert of Israel, a drip-irrigation system was used to fumigate the soil with methyl bromide for weed control prior to seeding tomatoes. Treatments employed were 2 non-fumigated controls, one with and another without plastic covering, and 3 fumigant applied treatments, all with plastic covering but differing in method and time of aeration. Tomato yields and weed control were significantly higher in fumigated soil although within the various methyl bromide treatments weed control results were similar. Testing for uniformity of methyl bromide gas flow revealed considerable differences in residual bromine occurring between the beginning and the end of the drip lateral. By using an inlet pressure of 0.5 – 1.0 atmospheres, minimal pressure drop along the line was achieved.**

Numerous studies have shown the effectiveness of methyl bromide in controlling nematodes, soil fungi, weeds, parasitic plants and soil insects (1, 3, 8), and many crops produce greater yields after soil fumigation (2, 4, 6, 7). However, methyl bromide does not totally eradicate all pests. Some weeds (e.g. *Malva, Erigeron* and certain legumes) are unaffected, as are a number of soil-borne diseases. Nevertheless, its effectiveness is sufficiently broad to justify its use in most cases. An important advantage of methyl bromide for weed control is the reduced danger of a residual effect compared to many other herbicides. A disadvantage is that the continued use on the same field may favor a multiplication of resistant weeds.

There are indications that increased crop yield after methyl bromide fumigation is due not only to the direct control of diseases, parasites and weeds, but also to the enhanced uptake of important minerals. Segelman (8) suggested that while fumigation destroys the nitrification bacteria, their regeneration is rapid due to the suppression of competing bacteria populations. McCants, et al. (5) reported there was a reduction in the efficient utilization of ammonia fertilizer after soil fumigation possibly due to reduced nitrification bacteria populations.

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