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DOES MAGNETIC TREATED WATER AFFECT PLANTS VIA SOIL POPULATION?

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Abstract

Magnetically treated water (hereinafter MTW) is water which has passed through the core of a device which contains a permanent magnet. The way MTW affects plants is not clear and one possibility is that MTW affects a plant indirectly through its effect on the soil microflora/fauna population. This theory was investigated with pepper and melon, plants which have specific (and contradictory) responses to soil disinfection. Response to MTW was observed in both crops unless soil was disinfected, thus supporting the theory of the soil microflora/fauna being involved in the MTW effect.

INTRODUCTION

Magnetic water (MTW) is the water that has been passed through the core of a device which contains a fixed magnet. For many years the effect of MTW has been a subject of research studies [1]. The use of MTW in industrial sectors as a means of preventing scale accumulation in circulating systems was widely discussed [2, 3]. Many research works were done to study the influence of MTW in agriculture, on soil leaching and minerals movement [4, 5, 6] and on crops, in the laboratory and

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in the field [7, 1, 6, 8]. However, the activating mechanism of MTW on plants is not clear, yet.

The change in solubility of minerals in water [2] might be one factor. Another possibility is a direct effect on physiological processes within the plant cells [9]. Also exists a possibility of an effect of MTW on the microflora/fauna population in soil [12], consequently evoking secondary responses of the plants. There exists an evidence of the magnetic properties of soil micro–organisms in nature: magnetic orientation has been found in bacteria [10]. A theory has been advanced that certain magnetic deposits on earth are of biogenetic origin, deriving from aquatic bacteria which contain magnetite [11]. Presence has also been reported of magnetic bacteria in anaerobic sediments of stagnant water which contained mineral iron–sulphur compounds [12] and large quantities of magnetic bacteria have been found in soils [13].

The objective of this study is to test a hypothesis that MTW has indirect effect on plants by a direct effect on the soil population. Accordingly, an experiment was designed to test the influence of MTW in soils with a natural rhyzosphere population as against soils in which the activity of micro–organisms was delayed as a result of disinfection with methyl–bromide.

The effect of MTW was tested on two different plants which generally respond in opposite manner to soil disinfection. Certain crops demonstrate serious negative responses to disinfection which affects the micro–flora/fauna population of the rhizosphere [14], in contrast to others which have a contradictory response. Pepper plants are adversely affected by previous disinfection of the soil owing to damage of the symbiotic soil population in the rhizosphere. This is in contrast to melon plants whose development is accelerated as a result of the disinfection treatment because it prevents development of pathogenic micro–organisms to which melon is sensitive [15, 16].

This work is based on the assumption that a comparative research study of disinfected soil and irrigation with MTW would provide information on the manner in which MTW affect the plants.

MATERIALS AND METHODS

Plant Materials

Melons of the "Galia" variety and peppers of the "Maor" variety.

Soil Preparation

The research study was carried out at the Experimental Farm of the Arava Research Station in the southern Arava. Peanuts were grown in the field two years prior to implementation of the experiment, while in the year prior to the experiment the plot was left fallow. Neither manure nor fertiliser were applied before seeding.

Prior to the experiment ten rows, each 1.8 × 40 m, were prepared. All the rows were covered with polyethylene sheets and four of them were disinfected by application of methyl–bromide gas below the sheeting from a heated container. Two outer rows served as marginal rows while the other eight rows were divided into four sections of 10 m each so that 40 sections were obtained. This enabled four replications of each treatment for each of the two crops. Four replications were sampled in each sample with at least ten plants from each replication.

Seeding

The plants were seeded in the spring. Corrugations, 8 to 10 cm deep, were opened up along the middle of each bed. The drip laterals were placed in the corrugations with drippers spaced at 40 cm intervals. The two crops were seeded in 'nests' in the same way: one nest close to the dripper and two 10 cm from the dripper on both sides. Two to three melon seeds or 3 to 4 pepper seeds were placed in each nest. After seeding, a layer of sawdust 1 to 2 cm thick was spread in the corrugation (about 1 kg of sawdust per 10 m of the corrugation). Fifteen days after seeding, the melon plants were thinned to 1 to 2 plants per nest, while the pepper plots were not thinned.

Irrigation

The plot was irrigated by "Netafim" pressure–compensated multi–season drip system (referred to by the manufacturer as the RAM system), with dripper flowrates of 2.3 litres per hour.Irrigation was applied by two separate systems, one in which water was applied through an "Agrimag"* magnetic device and the other in which the water was passed through a dummy device without the magnetic element.

The first system irrigated six rows (four with the MTW treatment plus two marginal rows), so that the flow of water through the "Agrimag" magnetic device complied with the application rate of 1.1 m^3/hour. According to instructions of the manufacturer the application rate should be at least 0.9 m^3/hour. The other system irrigated the remaining four rows of the experiment.

Prior to the seeding, a pre–irrigation of six litres per dripper wa applied. Irrigation after seeding was applied once a day in the first 30 days, and subsequently two daily irrigations were given, one with the daily fertilizer application and the other without the fertilizer application. The daily quantity of water applied during the first stage (the first five weeks of the experiment) was determined on the basis of 0.6 of the evaporation coefficient, and after this initial stage according to the evaporation coefficient of 1.0.

Fertilizer application

No fertilizer was applied in the first 12 days after seeding. Subsequently, the fertiliser was applied according to recommendations of the Ministry of Agriculture's Irrigation and Soil Field Service for the first stage of the growing season, at a rate of 1200 ml/dunam† of ammonium nitrate and 480 g/dunam of potassium chloride. These quantities were reduced 21 days after seeding to 900 ml/dunam of ammonium nitrate and 360 g/dunam of potassium chloride. according to the recommendations. No phosphate fertilizer was applied during the experiment.

*Supplied by Alir, Advanced Technologies, Israel

†1 dunam = 1000 m^2, or 0.1 hectare

Measurements

Fresh weight of the plant foliage of the two crops was determined 7 weeks after seeding, and the number of fruits per plant was determined one week later.

RESULTS

Plants were harvested after 49 days. The average weight of one plant was determined for pepper, the foliage weight per one square meter was determined for melons and the weight of immature melon fruits was determined.

The Effect of Fumigation with Methyl–Bromide on the Development of Pepper Plants

Soil disinfection which reduces the soil population also reduces symbiotic micro–organisms of pepper plants and hence a delayed development of pepper is expected [15]. The plants of pepper which were sown in beds sterilized before with methyl–bromide and in not–sterilized beds were harvested after 49 days. The effect of depression of the soil population on pepper – inhibition of the development of pepper plants – can be seen in Figure 1A.

The Effect of Fumigation with Methyl–Bromide on Melon Plants

Soil disinfection which reduces the soil population has a stunting effect on the sector in the population which has a pathogenic effect on the melon plants. Acceleration of the development of the melon is thus expected. This was actually confirmed for the weight of immature melon plants (Figure 1B) and for the foliage weight of the melon plants (Figure 1C).

The Effect of Fumigation with Methyl–Bromide on the Development of Pepper and Melon Plants in Plots Disinfected with Methyl–Bromide and Irrigated with MTW (BR + MTW)

In the fumigated soils, no significant difference in fresh weight of the pepper plants was found between plots which were fumigated and irrigated with MTW and plots

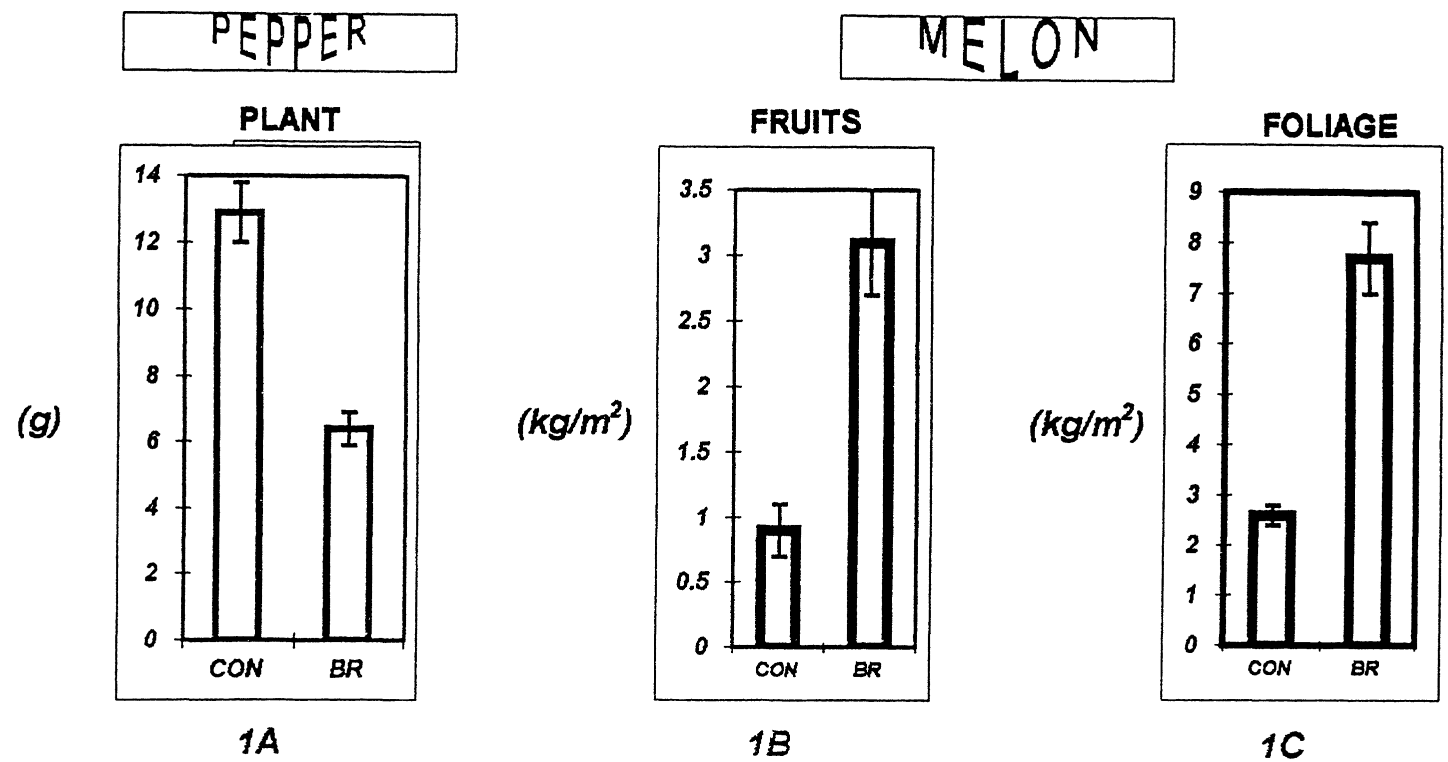

Fig. 1 The effect of soil fumigation on pepper and melon crops.
1A -pepper plants, 1B-mellon fruits, 1C-mellon foliage. Br-methyl-bromide treated soil. CON-control
Inhibition (pepper) and enhancement (melon) can be seen.

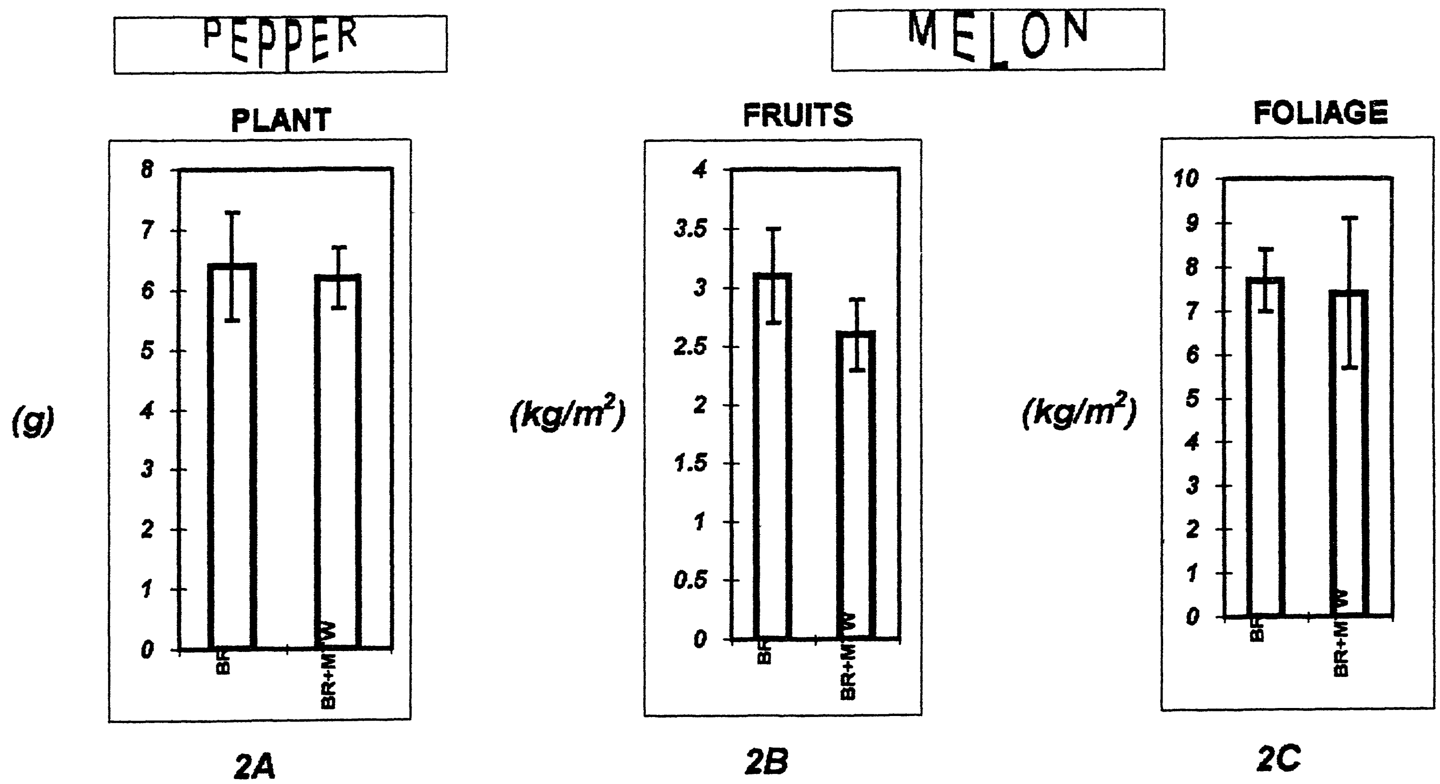

Fig. 2 The effect of irrigation with magnetic treated water on pepper and melon crops grown in fumigated soils. MTW: magnetic treated water. Other symbols as in Fig. 1
No significant differences between treatment with MTW and the control can be seen.

which were fumigated but irrigated with untreated water (Figure 2A). Similar results were obtained for the appearance of melon fruits (Figure 2B) and for the development of the melon canopy (Figure 2C).

The Effect of Irrigation with MTW on the Development of Pepper and Melon Plants in Plots not Fumigated with Methyl–Bromide

However, when pepper plants were irrigated with MTW in plots that were not fumigated with methyl–bromide, the treated pepper plants were bigger after 49 days (Figure 3A). Similarly, more fruits were found on melon plants (Figure 3B) and the canopy mass of melons was heavier (Figure 3C).

DISCUSSION

Previous studies have shown agricultural advantages of MTW with soil leaching and with yields [7, 2, 8, 4, 5, 6]. However, no unequivocal explanation has yet been found with regard to the activating mechanism of MTW on the plants. One assumption is the existence of indirect influence of MTW on plants by affecting the soil micro–flora/fauna. The objective of this study was to investigate this possibility that the soil population is involved.

This was done with soils which were disinfected by prior treatment with methylo–bromide compared to soils which were not disinfected. Two crops, peppers and melons, were selected for the research because they have opposite responses to soil fumigation [13, 15]. Melons respond with accelerated development in the fumigated soil, apparently due to the damage to the pathogenic soil population. On the other hand, development of peppers in the fumigated soils is delayed owing to the damage caused to its symbiotic part in the soil population, namely mycorrhiza which affects the availability of phosphate for the plant [15, 14].

The opposing reactions of melon and pepper are reflected in the difference in the morphological development of the plant in the two crop environments: in contrast to the non–disinfected soil, the vegetative development of melon increased in soil

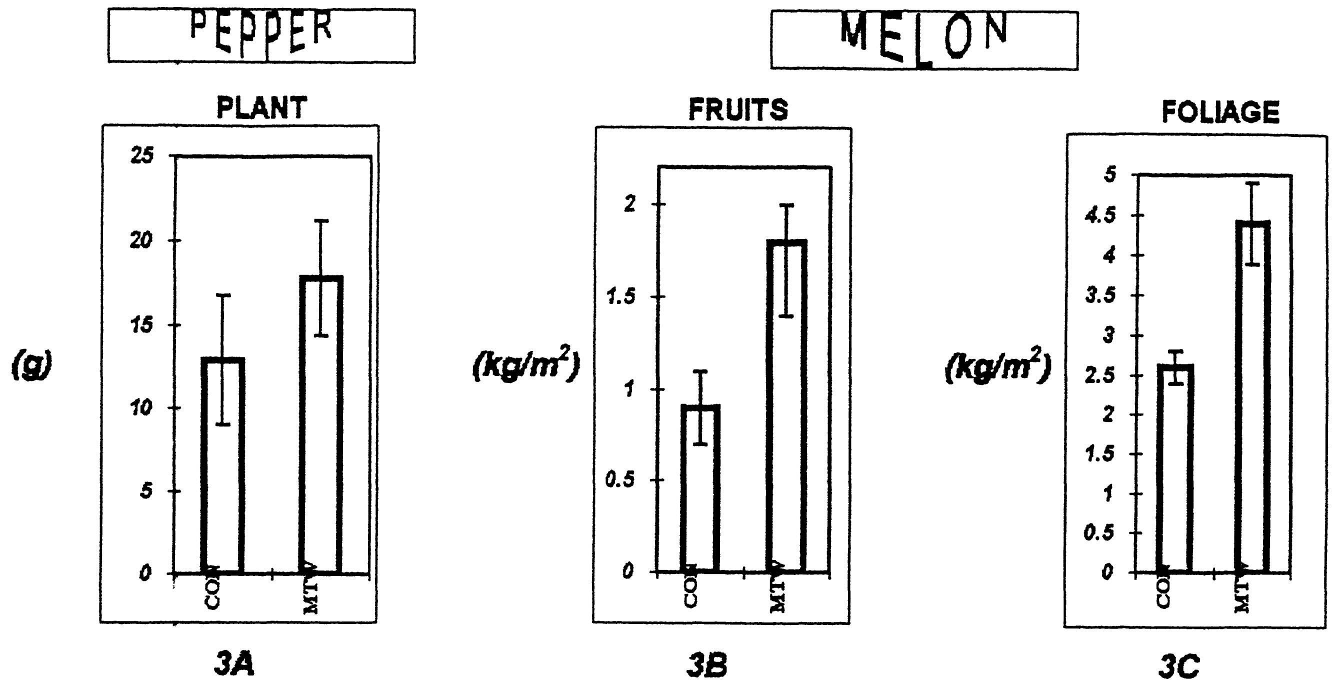

Fig. 3 The effect of irrigation with magnetic treated water on pepper and melon crops.
Symbols as in Fig. 2.
In the non-fumigated soil the effect of irrigation with MTW can be observed in both pepper and melon plants.

treated with methyl–bromide (Fig. 1C), as well as maturation of the melon fruits (Fig. 1B). The vegetative development of peppers was adversely affected (Fig. 1A).

Influence of Irrigation with MTW

a. Morphological development of melon and pepper plants

In non–fumigated soil the irrigation with MTW accelerated the morphological development of the pepper plants (Fig. 3A) and of the melon plants (Fig. 3C). On the other hand, in soils in which the population of the micro–organisms was adversely affected by the methyl–bromide fumigation, MTW had hardly any effect on the morphological development of the two crops (Figs. 2A, 2C). This result conforms with the assumption that irrigation with MTW affects crops by means of the soil population and that this effect is not much significant when the activity of the soil population is stunted, as in the case of disinfected soil.

b. Time of appearance of the melon fruits

The differences in the effect of MTW on the time of appearance of the melon fruits is apparent also in the results obtained in the fumigated soil (Fig. 2B) and in the non–fumigated soil (Fig. 3B). This finding also agrees with the assumption which infers a possibility that the MTW treatment affects the plants through its effect on processes linked to the soil population.

CONCLUSIONS

It was found that irrigation with MTW affects the development of pepper and melon (Figs. 3A and 3C), and results in the attainment of earlier melon yields (Fig. 3B). These effects were not found in the disinfected soil (Figs. 2A, 2B and 2C).

Those results conform with the assumption that irrigation with MTW affects the crops by having an effect on soil population. It is suggested that this research work be continued with the objective of determining the effect of MTW in controlled systems of known soil populations , both pathogenic and symbiotic.

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