

Control of Soil-Microbes for Using Air-Injection System and Attached Ozone-Gas Generator

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Abstract

Agricultural soil treatment was carried out at the relatively high concentration of mixed Air and Ozone gas. It supplied Air-Liquid mixture phase by Air-injection-system with sub-surface drip irrigation tube. Inner soil holding oxygen content readily improved aerobic condition with irrigation water supply mainly to root area. Applied Ozone gas for agricultural soil treatment was gas-phase supply for unfavorable Soil-microbes ex. Nematode sp. One of the results of parasitic nodule type of Nematode sp. indicated that it very sensitively reduced, while independent type of Nematode sp. were insensitively and externally reduced. It was estimated that very important point of Gas-phase Ozone application had intermediate soil treatment for plant cultivation period with Air-injection-system, and has an alternative for methylene-bromide soil treatment (years of 2005 are under control by international protection law of ozone region).

Key Words

Ozone, Nematode, Soil treatment, Disinfection, Sterilization, Plant, Cultivation, Agriculture, Air, Gas, Injection, methylene, bromide, methyl, parasitic, independent

Introduction

Protection methods against damages by pest control on agricultural products are very easy to select and apparently efficacious. The effectiveness and the cost reduction are very important factors to select from them. Consideration toward environmental safe plays the most important role in our basic concept of the protection. Weed control by herbicide, fungicide are major protections for plant diseases. Research and developing field work usually need target-sites.

Through this field study, we aimed to improve agricultural production and impacts of organic matters on environments. Various agricultural soil treatment methods have been developed so far. The basic concept of control of damages by diseases and pests has been focused exclusively on applying pre-treatments and intensifying concentration of agricultural chemicals. Any type of current soil treatment methods do not work effectively after planting. Nobody has imagined that soil treatment could be applicable after planting.

This fields-study of Ozone-gas injection method had wide variety of possibility in applying plant, marine and fresh water cultivation, etc. It seems that Air-injection-system can apply to wide variety of fields requiring high oxygen demand field and water mixing field.

The plant-cultures in various type of water- rock- sand- rockwool- have been almost successfully, especially in applying to oyster bed. In the case of oyster bed, the air-injection requires very low-energy because it does not require pressure. Applications of Air-injection system to other fields are also very useful, for example, pond-cleanup field and so on,

- *Dam and barrage maintenance
- *Green-fields to avoid the risk of water-mist
(Sprinklers induce mist, vaporization which make temperature cool down and induce decrease of plant growth),
- *Recycled (after treatment of waste water) water application are essentially carried on under ground or under cultivation soil for irrigation.

It seems to be easy to supply Ozone-gas, because only requiring pipe-line. You may find releasing ozone gas out of the first emitter of the tape. Ozone gas will also run away through the most fragile cracks parts of soil.

Air-injection-system can induce rich supply of air into soil and well holding water-air-capacity to form conditions enough for aerobic stage. Soil-microorganisms activated principal reaction of bacterial digestion to reduce organic substances. The growth of Soil-microorganisms depends on organic supply, for example, compost, cow- pig- chicken-manure, food-waste disposal, plowed plant residue and so on.

Supply of air had some effect on anaerobic soil-microorganisms, except inside of soil granule. Plant and soil diseases were not selective inhibition for air supply. When aerobic condition becomes well, it increases non-needle type of nematode and consumed not only bacteria, spore, spawn (hypha), organic fragments but also all others available (also live diseases, bacteria and viruses). In case of increasing parasitic nodule type of nematode, plant roots induced very strong damage for nutrient and water uptake, the external effect appears at plant shoot, flagging leaf, growth inhibition, sprout damage, etc. Therefore the deficient water up-take induced plant disease. Air-injection-systems are not enough for protection of plant diseases, so soil pre-treatment are especially required for pre planting or sowing. If intermediate growth period were damaged by plant-root diseases, it would be recommendable to provide air-injection systems with OZONE GAS GENERATOR. Ozone-gas showed generally non-selective effect of growth inhibition for microorganisms and sterilization effects. Nematode and soil microbe are more complicate, depending on physically inside of soil granule. We are approaching to soil granule surface at the relatively high concentration of Ozone-gas using Air-injection-system and sub-surface drip irrigation tape.

Materials and Methods

Air-injection-system

The Air-injection-system was selected, with using Mazzei injectors (patented). Air aspiration can be controlled by differential pressure of in- to out-water flow speed. Additional control of intake air flow were easy install for suction part, use small valve or some kind of resistant methods. A lot of people misunderstand that the term of Air-injection is tantamount to dissolved oxygen concentration. Air-injection-system carry on mixing air-water mixed phase flow. And pressured air-water mixed phase induced super-saturation effect, mixing air and water.

Some type of Mazzei injectors are shown below;



This injector can be used not only for mixing air, but also for using stable mixing liquid fertilizer, mixing hot- cold-water, different concentration of substances. Besides these usages, it can be used to suck air without additional pressure units in the deep sea and deep water.

The photo shows inlet at the left side, outlet at the right side. Those injectors can be easily installed for using regular water supply parts, joint and pipe etc.

Air-injection-system is shown below;



The lower Mazzei injector worked with sucking Air, and upper Mazzei injector sucked fertilizer. The middle valve controls separation of water flow. Fertilizer can be more controlled with the attached liquid flow gauge. Left side upper are pre 200-mesh filter. Both side gauges show pressures. The white tank is a liquid fertilizer.



The Fertilizer mixing unit usually works each time of irrigation. The cylinder was connected by a soft-tube with the sucking fertilizer unit. About 0.3mm stainless-steel mesh is installed in order to avoid the risk of foreign articles to be sucked.



Irrigation tubes and regular water equipment joints were connected with a special tubing adaptor. This system will be applicable with other standardized parts, provided that the diameter and thickness are same.



“Rakuten-tape” means literally in Japanese that it is easy to install the irrigation tapes, helpful to save their trouble and to enjoy the beneficial quality of the tape.

This bobbin sample is a 1000 m roll, and irrigation point are 10cm pitch between each pore for explosion of relatively highly pressured air, together with flush water pushing out through holes. This tape can be cut every 40 cm. Characteristic point indicated at the lower left of the photo below. One of four cavities is blowout by water pressure, and the reason why only one cavity functions will follow next. One of major Irrigation tape (tube)’s problem is plant root penetrating into the cavities to chase water, consequently tube cavities (pore) are clogged by root, inducing uneven water supply and uneven plant growth.

This "rakuten-tape" has effective mechanism to solve problems of roots. Photo shows four closed cavities. Four cavities could not be broken down at same time for physiological reason. If one of four cavities will be clogged, another of remaining three ones automatically will function.

The tapes were laid underground to irrigate air and water. Set-up of the tape position is near the plant root, but not too far and not too closed, depending on the plant species. The tape was covered by soil, 15cm in the depth without the waves and folds,

throughout the field. At constant level, slight attention is required for preventing snag, punch, stretch, minor trail for sharp stone, heat and burn etc., and same caution also toward soft plastic material for "Poly Propylene".

This experiment was conducted at a green house having the bell pepper farmland, shown below;

The Soil surface showed wet lines and dry surface.

"Rakuten-tape" was buried about 10 cm in depth from the soil surface. This plant of green bell pepper was at growth stage of about two months after planting.

"Rakuten-tape" was buried at both sides of the plant. The length of ridge was about 70 meters, totaling 140 meters tapes each ridge. Plant distances are about 60 cm, like "cross-stitch".

The ridge was set about 1 m in width and about 20 cm in height. The concept of maintenance of growing was "three shoots for one root". This spring weather conditions were unfavorable to plant growth in Japan, such as low daylight, low temperature and high humidity.

"Ozone" gas being applied to agricultural disease-control of farmland soils.

Farmland soils condition have various factors to be taken into consideration: such as granule size, hardness, organic material quality contents, acidity or alkalinity(pH), mineral contents for major or minor substances, microorganisms activity variety population, etc. Ozone-gas effect is expected of sterilization for nonselective microorganisms, but most of the published data referred to only dissolved Ozone-gas. General concern is exclusively on dissolved Ozone-gas. Dissolved Ozone-gas in liquid water induced much more water supply and very wet condition, consequently the more soil air-phase decreases, the more water storage increases, and at the next stages, anaerobic microorganisms activates more strongly. Therefore, plant diseases increase, roots have damages, shoot have fungus, so such troubles induce plant destruction.



Introductions of New technology "Ozone-gas-injection-system" for farm land soil.

Conventional irrigation with excessive water causes many kinds of troubles which could be easily solved by our new technology.

"Ozone-gas-injection-system".

Ozone-gas supplied by Ozone-gas generator. Generated Ozone-gas directly was supplied to air-suction parts for using pipelines connecting with Air-injection system, Ozone-gas concentration depends on generating speed and air supply speed. On these experiments, the former is 0 to 16 mg/litter and the latter is 0.6 litter / 1 m of irrigation "Rakuten-tape" irrigates 4 litter water per hour. Ozone-gas was measured at under 3mg/l supplied in the form of water-phase. However, 13 mg/l concentration was indicated gas-phase after set up under scheme. Full length of "Rakuten tape"(total 1,000m) was used for this Ozone Gas soil treatment.



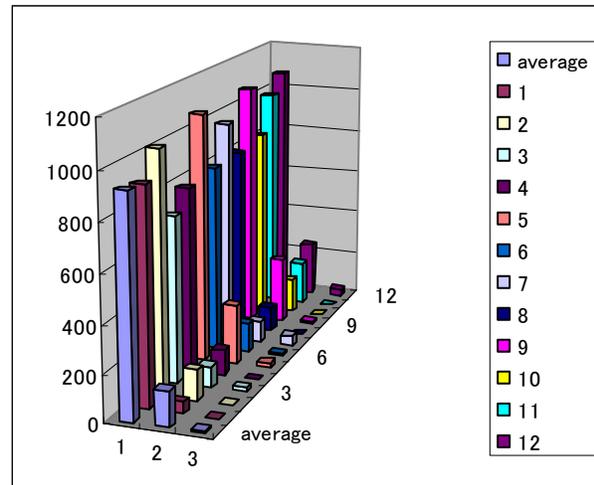
Upper photo shows the direct detection from a out-let, which emits bubbles with ozone, of irrigation tube. For your reference, we take off the sensor cover for this photo. The water sample was collected in the plastic beaker and analyzed through coloring reagent. Measure tool showed good evidence that this Ozone-gas-injection-system was supplied through gas-phase methods.

Results and Discussion

New technology of "Ozone-gas-injection-system" was applied to green bell pepper farm land soil. Soil treatment at the maximum concentration of Ozone-gas generation for continuous 2 hours was applied for continuous 3 days before transplanting. Our viewpoint of nematode and analytical result was shown below;

The 12 points of various farmland fields were collected before the treatment (1), after the first treatment (2), after the second treatment(3) on the horizon bar..

Nematode species of Meloidogyne were strongly reduced by almost 90% for the first treatment, reduced 921 to 153 at the average. After three days, the second soil treatment was done, the average data showed 153 to 11. Counting basis were Meloidogyne / 50 ml soil.



This results showed Ozone-gas-injection-system had great possibility for soil treatment method, especially in agricultural fields. The drastic reduction of nematode indicates that very large amount of field can be treated evenly throughout. Then, we strongly suggest that Ozone-gas is strongly reduction substances. That is why supplying gas-phase of ozone will be an alternative or more, reducing hazard organic material contamination as well as remedying contaminated fields. Because the large fields were contaminated by low concentration of oil- chemical- biological-contaminants, will be effectively treatment (reduction) by this type of irrigation methods of Ozone-gas-injection-system.

Agricultural land applications of Ozone-gas-injection-system were estimated that nematode protection of soil treatment required two times or more times treatments.

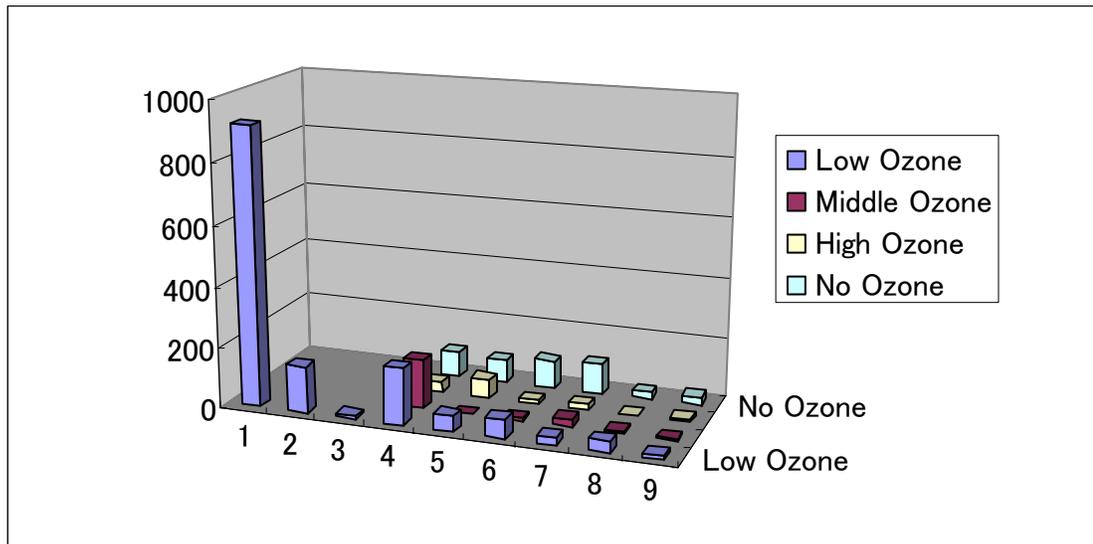
Very important suggestion for soil treatment

The current agricultural land treatments are only previous treatment before planting. Now we had new technology of Ozone-gas treatment, which made it possible to continuously use during plantation period. This is very important factor, and the advantages of Ozone-gas had great possibility for replacement for methylene bromide treatment. Methylene bromide methods will be prohibited under law at 2005/Jan/01. And another advantage of Ozone-gas is that it is not necessary to release the gas. Ozone-gas life is very short, only 20 min in air-phase, and converts into oxygen in soil

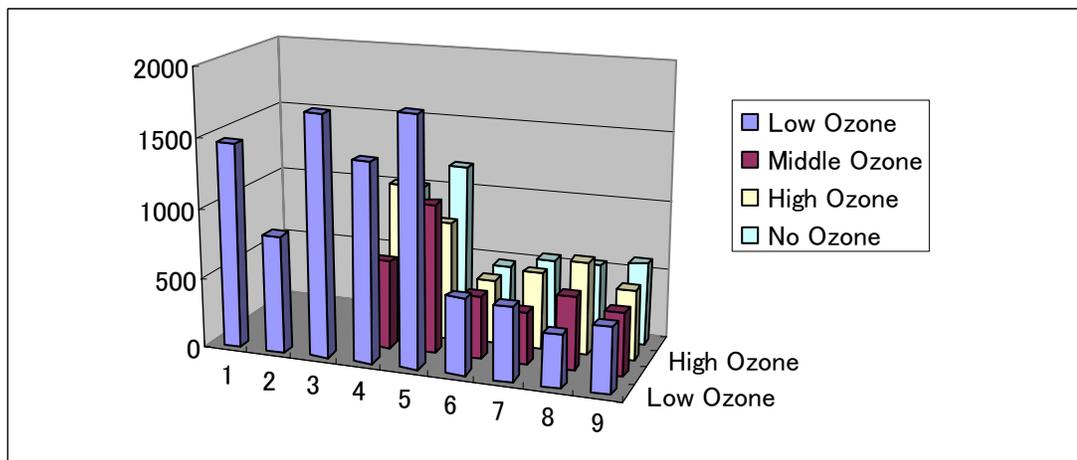
conditions. Additional effect of Ozone-gas released from soil will be protection for plant shoot diseases, now we are approaching to a green house. We have already found that high concentrated Ozone-gas damaged shoot and leaf. Ozone-gas concentration inside the green house as intermittent supply and diffusion technique are very sensitive factor, and we will set up an experimental work at some green house soon. This should be an excellent challenge.

Intermediate Ozone-gas soil treatment by "Ozone-gas-injection-system" showed the under graphic. Continuous treatment each 2weeks three times, and estimated various variety of nematode. Applications of Ozone-gas had been done one time every two weeks so far and we show you only the results obtained from the first to third time.

Influence of continuous Ozone treatment, nematode *Meloidogyne* sp.



Influence of continuous Ozone treatment, nematode *Rhabditida* sp.

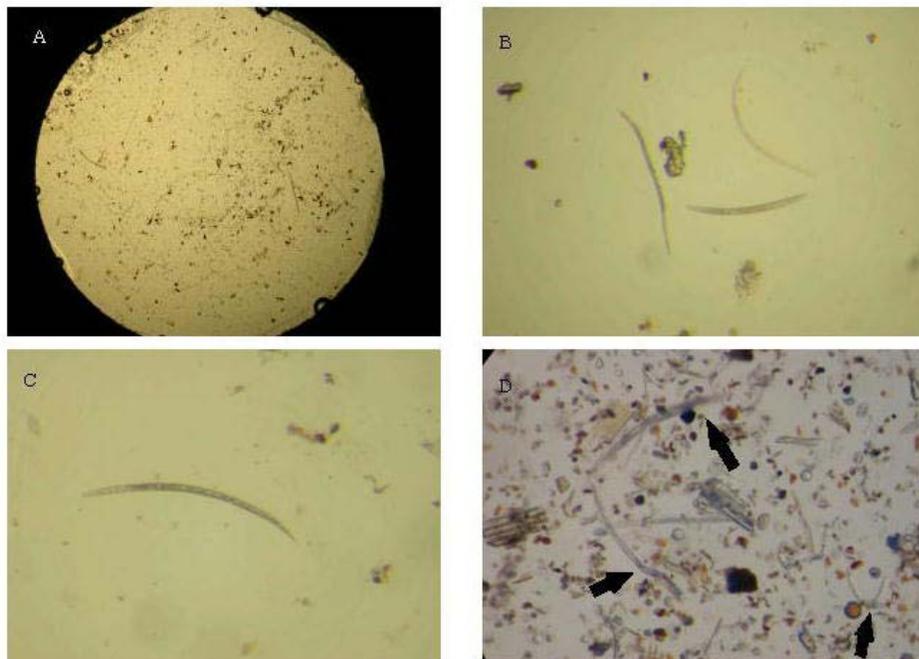


Graphic under mean are Ozone-gas pre- or after treatment, under shown

- 1 : before the treatment
- 2 : after the first treatment
- 3 : after the second treatment
- 4 : at the time of two weeks after planting before treatment
- 5 : one day after the treatment at the time of two weeks after planting
- 6 : at the time of four weeks after planting before treatment
- 7 : one day after the treatment at the time of four weeks after planting
- 8 : at the time of six weeks after planting before treatment
- 9 : one day after the treatment at the time of six weeks after planting

After two weeks of planting, 20-30 % of nematode recovered their population, then above-mentioned methods of Ozone-gas intermediate soil treatment were applied. Parasite type of nematode (*Moloidegyne* sp.) was strongly inhibited after each treatment. Low concentration (under 5 mg/l) of Ozone-gas soil treatment was slightly effective with air only. Clean-up by nematode (*Rhabditida* sp.) slightly increased each ozone-gas treatment, causing increase of bacteria- nematode-microbial- organic fragment- remain. The results of continuous treatments showed that parasite nematode immediately decreased while following clean-up nematode decreased mainly due to the starvation or cannibalism. This information supported that ozone-gas treatments were selective effect or concentration effect.

For your reference, the photo of nematode is shown below;



D : Black allow indicates that nematode got damages

Conclusion

New technology of Ozone-gas-injection system was developed by CCS & Associate. This system will mix Ozone involved air and water and then distribute the mixed sub-micron pore size bubble water through the dripping tapes (Rakuten-tape) under layer of farm soils. This will contribute to the improvement of the growing site for plants. For the purpose of protection of the global Ozone layer, soil treatment substances "methylene bromide" will be prohibited in 2005 Jan. 01. Various methods of soil treatment, steam, sunlight heat applied with flooded water consumes a lot of working time and requires unnecessary treatment stages and additional composts, drying period, frequent rotary works, and big consumption of carbon-dioxide sources of fossil fuel, and increased financial burden. Furthermore, those soil treatment methods can not fulfill the expected function fully and can not be applied as intermediate soil treatment during plant growing stage. Regular soil treatment methods have possibility only for pre plant soil treatment, not after plant growth.

Our developed new technology of Ozone-gas-injection system, as mentioned above, will charge ozone-bubble water into irrigation tapes in under ground. Generally speaking, the current soil treatments took more than 2 weeks so that it will not contribute to improvement of effective use of farm. However, with use of floating Ozone-gas bubble methods of "Ozone-gas-injection-system". It controls nematode of harmful plant disease in soils. Developing Ozone-gas-injection-system attached with MIC "Airjection" system will bring out this system combined with micro-bubble method. Less 100 micro meter size of bubble could provide us with much innovative hints for new ejector fields.

New technology of "Ozone-gas-injection-system" pointed out under characteristic results and theoretical predominant.

* Reduce water use.

Consumption water decreased, compared with other sprinkler irrigation. No mist, No noisy sound by sprinkler and showering, water sound. No wet for grass fields.

**Pioneer work field for near future.

Reuse of treated water out of the waste water treatment plant. No mist contaminations occur in the field, avoid the risk of virus, pathogen, unfavorable material. Ozone sterilization effect will be found in grassland protections for plant pathogen.

***Additional effect for direct rooting supply.

Reduce Ground-water contamination. Irrigation tape under soil layer provides directly Air, Ozone, and fertilizer to roots and wash up root area with "Ozone-gas-injection-system". It can be simple to control plant growth and nutrient requirement. The most interested thing of this system was protection of nitrate

contamination in ground-water. Minimum nutrient requirements can be supplied through this system, which allows us to minimize use of fertilizer (pre-sprinkle fertilizer and additional ones).

The efficacy of regular fertilizing methods indicates only 5 to 10% utilization efficiency of fertilizers. On the contrary, Ozone-gas & Air-injection system could load liquid fertilizers, and the utilization efficiency is more than 70% and minimized excess ion discharge into ground-water.

****Aerobic conditions to maintain soil microbe

For regular hand irrigations is most effective way for washing up roots, excess fertilizer release, exchanges of air-phase in soil. General irrigation tube-tape-sprinkler-methods only influence water holding capacity. Soft water irrigation is stressful for plant growth. High moisture contents and anaerobic conditions induced growth inhibition, plant diseases, pathogen growth for soil surface.

Aerobic conditions are very favorable for respiration, nutrient substances uptake - evacuation of roots. Irrigation must need wash-up function. Developed "Ozone-gas-injection-system" functioned successfully for all kinds of irrigation requirements.

No talk! Yield up, and good conditions of soil matter induces good quality of harvest. Aerobic nematode can clean up plants and organic residues.

Sucking energy is using water flow energy, so needs no additional energy.

In Japan, we call this system "Sanso-Nouhou", that is, "Get Healthy Food Grown with Aerobic Condition". This also includes the meanings of decreased pesticide, decrease chemical fertilizer, and safety agricultural products.

We wish for your presence life, with using "Ozone-gas-injection-system".