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**RESEARCH ARTICLE**

# Influence of Organic Fertilizers on the Issue of Carbonic Gas in the Soil under Vegetable Crops

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## ABSTRACT

The article discusses the use of manure and other organic fertilizers serving for plants as a source of mineral nutrients with the release of $CO_2$, when decomposed, it saturates the soil air and the surface layer of the atmosphere contributing to the plant's air nutrition. For a well-known reason that recently, around the world, as an economically pure organic fertilizer of animal origin, they began to be used to prepare nutritious mixtures for obtaining environmentally friendly crop products from crops, while it would justify the economic feasibility of using its cheap preparation and rising prices for industrial fertilizers. It has been proven that the application of various types and doses of organic fertilizers for legumes and peppers helps to increase the content of organic matter, nutrients (NPK), humus, carbon dioxide in the soil, as well as increase the growth and development of plants in different periods of vegetation. It has been established that the higher the content organic matter in the soil, the more it emits $CO_2$ under conditions of aeration and humidity, and the correlative high relationship confirms the contiguity and tightness between these parameters, where $P = +0.94+0.04$ (beans) and $P = +0.97+0.02$ (pepper).

**Key words:** Carbon dioxide, compost Absheron, dry weight, easily hydrolysable nitrogen, gray-brown soil, humus, legumes and vegetables, microorganisms and enzymes

## INTRODUCTION

In modern agriculture, vegetable growing occupies a special place and given the soil and climatic conditions, socio-economic opportunities, population, and livestock development, especially regional territories and the availability of natural resources of Azerbaijan, it can be noted that there are sufficient opportunities for providing the population with necessary types of vegetables, and technology their cultivation is expanding. The Absheron Peninsula is one of the densely populated areas and the presence in this region of various kinds of organic waste allows you to use them after processing as organic fertilizers.

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Field and production experiments on the development of the expansion of vegetable plots showed that the soils allotted for these crops require the annual application of organic fertilizers, which contribute to increasing soil fertility and improving the quality of vegetable crops.[1]

Agricultural plants live simultaneously in two environments: In the soil and the lower atmosphere. By leaves, they absorb carbon dioxide of its air, and by roots – water, mineral ions, and some organic substances from the soil.

On average, the dry matter of plants contains 45% carbon and 42% oxygen. The source of carbon for the synthesis of plant organic substances is air nutrition.

Carbon dioxide enters the leaves with air through the "stomata," densely dotting the leaf blade.

At the same time, water evaporates through the stomata. The total surface of the leaves exceeds

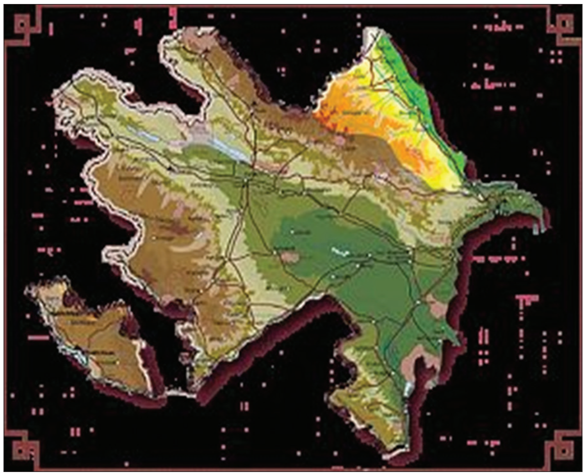

**Figure 1:** Geographical map republic of Azerbaijan

(by 20–70 times or more) the soil area occupied by the plant, which creates good conditions for the absorption of $CO_2$ and the energy of the sun's rays by green leaves.

They owe this color to chlorophyll, whose cosmic role was convincingly revealed by Timiryazev, because without chlorophyll, plants could not capture the energy of sunlight, and therefore, store it in the form of potential energy of the crop. The content of chlorophyll in fresh leaves is slightly 1–3 g/1 kg or about 1 mg/25 $cm^2$ of leaf blade.

However, the dispersion of this pigment is so great that the total surface of its grains is about 200 times higher than the total surface of the sheet. The work performed by chlorophyll is of high intensity. For 1 h in the world, every milligram of chlorophyll promotes the assimilation of a sheet with 5 times more carbon dioxide.

During a bright summer day, the leaf accumulates up to 25% of new organic substances; 5–10% of them are spent on breathing. In total, the plant oxidizes during respiration from 15–20 to 30–50% of the daily formed carbohydrates.[2]

Every year, on the entire surface of the globe (150 million $km^2$ of land and 360 million $km^2$ of oceans and seas), plants synthesize about 400 billion tons of organic matter.

If there was no replenishment of carbon dioxide in the atmosphere, then in about 4 years, it would be completely bound by green plants.

During rotting and burning, part of the $CO_2$ absorbed by plants returns to the atmosphere.

Regulates the concentration of carbon dioxide in the air of the oceans, containing two orders of magnitude more $CO_2$ than the atmosphere. The solubility of carbon dioxide in water depends on temperature and pressure. In the summer, when the temperature of the water rises, the solubility of $CO_2$ decreases and part of it disappears into the air.

On the contrary, in winter, with a decrease in water temperature, a certain amount of carbon dioxide again moves to water basins.

However, for plants, it is just important to increase the $CO_2$ content in the air during the growing season.

Typically, the carbon dioxide content in the atmosphere is only 0.03% (by volume), which corresponds to 0.5565 mg for 1 L.

In a meter long layer of air directly adjacent to the earth, over one hectare, there is only 5–6 kg of carbon dioxide.

Compared to the needs of plants, this is not much.

Hence, sugar beet assimilates about 300 kg of $CO_2$ per 1 ha during the period of intensive growth when the root crop is 400 cm/1 ha.

Even a 10 m air layer above the soil contains only 57 kg of this gas, another 50 kg is released during the respiration of the roots during the life of microorganisms, and finally, about 47 kg/1 ha is released during the respiration of the ground part of plants.

This proves that in practice, there may be a shortage of carbon nutrition.

In the experiments of Bussengo with the same illumination and temperature, the ratio of the volumes of carbon dioxide located by leaves when parallel placed some in pure carbon dioxide and others in a mixture of it with atmospheric air were 5:1. Indeed, a multiple increase in the concentration of $CO_2$ in ambient air has a positive effect on crop yield.

How to increase it?

First of all, the abundant use of organic fertilizers, the mineralization of which produces a lot of carbon dioxide.

After applying 20–30 t of manure per 1 ha to the soil, it is released, then it goes from it to atmosphere of 5–7 t $CO_2$.

When the carbon dioxide content in the air is $<0.01\%$, photosynthesis stops in plants.

Crops, trying to overcome the lack of carbon dioxide in the atmosphere, develop a leaf surface.

In experiments with an artificial increase in the amount of carbon dioxide in greenhouses and in the field, a noticeable increase in yield was observed.

Plant roots absorb only 1–5% of the $CO_2$ they need, while the rest is absorbed by the leaves.[3]

The carbon dioxide that entered through the roots is partially fixed during carboxylation with the formation of organic acids – malic, oxalic, succinic, and fumaric (most of all, the first two) and partially moves unchanged to the leaves.

Of course, $CO_2$ fixation observed in the tissues of root crops, tubers and roots can occur only when using the energy of other processes.

Moreover, this means that from this assimilation of carbon dioxide, the potential energy accumulated by the crop does not increase.

Nichiporovich (1956) showed that during the period of the most intensive growth of plants, the daily increase in total dry weight per hectare of crops is on average 80–150 kg, in the best cases, it reaches 300 and even 500 kg, while during the day through the roots by plants, it is absorbed in the form of ions of approximately 5–10.5 kg of mineral substances.

Plants assimilate 150–300 and even 1000 kg of carbon dioxide from the air through the leaves during the day – an amount that corresponds to the $CO_2$ content in the air layer over a hectare 30–60 m high, this amount is delivered to the plant due to convection current of air.

The most important source of replenishment of carbon dioxide in the atmosphere is soil.

According to approximate estimates of Uspensky (1956), during the year during the breathing process, the heterotrophic population of soils of the earth's surface releases 63 • 109 t and carbon dioxide (soil invertebrates – 3.7 • 109, bacteria – 51.4 • 109, and fungi – 8.8 • 109).

To this should be added, the carbon dioxide released during the root respiration of plants (71.5 × 109 t/year).

In total, the annual amount of carbon dioxide forming in the soil of biological origin is 13.5 • 1010 t., which, in general, corresponds to the annual demand of the terrestrial flora (8 • 1010 t. $CO_2$).

The creation of permanent sources of carbon dioxide supply to plants is one of the important factors in increasing crop yields.[4]

## PURPOSE AND METHODS

An experimental study of the effect of organic fertilizers on the accumulation of organic matter and the release of carbon dioxide was carried out in the village of Govsany.

Field and laboratory experiments were carried out in 4-fold repetition in six varieties with legumes (beans and lentils), in seven varieties with pepper, tomato, and eggplant. The plot is irrigated. All agricultural activities were carried out in accordance with agricultural regulations on the use of fertilizers. The following fertilizers were used: Manure in semi-matured form from cattle, contain a total nitrogen of 0.4%; phosphorus – 0.28%; potassium – 0.60%; and organic matter – 21%; C:N ratio is 19.

Solid household waste – municipal solid waste (MSW) contains organic matter from dry weight – 80%, nitrogen – 0.75%, phosphorus – 0.50%, potassium – 0.3%, trace elements – 0.3–0.5%, and ratio C: N – 19.

Sewage sludge – WWS contains in its composition dry matter – 52%, organic matter from dry weight – 36%, nitrogen – 3.8%, phosphorus – 2.6%, potassium – 2.0%, and ratio C:N – 12.

Compost Apsheron is prepared from MSW – 40%, WWS – 30%, manure – 10%, crop residues – 17%, and ash – 3% and contains nitrogen 1.95%; phosphorus 1.97%; potassium 1.63%; organic matter 24%; and C:N-16 ratio.

The sludge of the Absheron canal contains a total nitrogen of 1.60%; phosphorus – 0.17%; potassium – 3%; ash – 79%; organic matter – 21%, as well as trace elements; microorganisms and enzymes, the ratio of C:N – 16.

For the agrochemical characterization of the test soil, soil samples were taken at a depth of 0–100 cm. Laboratory analyses were carried out to study the content of easily hydrolyzable nitrogen according to the method of Tyurin and Kononova; mobile phosphorus according to Machigin; exchange potassium according to Protasov on a flame photometer; humus according to Tyurin; organic matter according to Vorobyov and Avaev; and carbon dioxide production according to Arinushkina.[5]

## RESEARCH RESULTS

It is established when applied to the soil 30 t. Organic fertilizer (manure) the amount of carbon dioxide per hectare compared with the non-fertilized option exceeds 100–200 kg [Figure 1]. The significance of $CO_2$ is determined by the fact that, for high yields per day, for each hectare of sowing, 200–300 kg/ha is required for vegetables.

Organic fertilizers introduced into the soil serve as an energy material for the active activity of microorganisms and are a supplier of plant nutrients. It should also be noted that high doses of fertilizers improve both the biological and physicochemical properties of the soil and at the same time water and air conditions.

The results of field and laboratory experiments conducted with legumes in the conditions of the gray-brown soil of Absheron showed that in the variant where Absheron compost was dispensed at a dose of 20 t/ha, the $CO_2$ content was 82.3 mg/kg • h/m$^2$, which is 32.1 mg/kg • h/m$^2$ more compared to the control.

If we transfer the obtained data to a hectare, then it can be seen that, as a result of decomposition of 20 t of Absheron compost, the emission of $CO_2$ is 770 kg more than in the control.

When 20 t/ha of sludge from the Absheron canal was introduced into the soil, the amount of $CO_2$ was 89.5 mg/kg • h/m$^2$, which is 39.6 mg/kg • h/m$^2$ more than in control, and if converted to hectare, it turns out that with the decomposition of 20 t of the Apsheron canal, the $CO_2$ emission is 950 kg more compared to the control.

We conducted field and laboratory experiments to study the effect of organic fertilizers on growth and development, productivity, fertility and quality indicators, as well as the production of carbon dioxide under legumes and vegetables, the results of which are given in Table 1.

Studies conducted under vegetable crops showed that 10 t/ha of Absheron compost is applied to the soil, the amount of $CO_2$ is 244 mg/kg • h/m$^2$, which is 18 mg/kg • h/m$^2$ more than control.

If you translate the data obtained per hectare, then daily 432 kg of $CO_2$ will be required for vegetable crops.

When 5 t/ha of the Absheron canal is introduced into the soil, the $CO_2$ content is 237 mg/kg • h/m$^2$, which is 11 mg/kg • h/m$^2$ more than the control, and when transferring crops for vegetable crops per hectare, 264 kg of $CO_2$ are required daily.

We also studied the production of carbon dioxide, depending on the degree of decomposition of organic fertilizers under pepper, the results of which are given in Table 2.

As shown from the data in Table 2, the content of $CO_2$ allocated during the growing season from hectare on average 3 years varies from 198.5 to 362.1 kg/ha. The increase in comparison with the control of the allocated $CO_2$ at 20 t/ha of rotted manure is 155.8 kg/ha; partially rotted manure 148.4 kg/ha; at 20 t/ha of solid household waste 150.5 kg/ha; and 20 t/ha of the Absheron canal 153.0 kg/ha. The highest increase rates were observed when using 20 t/ha of Absheron compost, where the increase was 162.6 kg/ha, which is 6.8 kg/ha of accumulated $CO_2$ more than rotted manure.

The dry mass of plants over an average of 3 years varies according to the experimental options from 275.2 to 492.9 kg/ha; harvest from 69.3 to 122.6 c/ha. The increase with the addition of 20 t/ha of Absheron compost for the crop is 217.7 kg/ha or 80.9%, and the yield is 50.6 kg/ha or 71.6%.

We performed a mathematical calculation to identify the correlation between the content of organic matter

**Table 1:** The effectiveness of organic fertilizers in the accumulation of dry matter and the release of $CO_2$ and its significance in the nutrition of legumes and vegetables

| No. | Options | mg/kg • h/m$^2$ | The increase compared with the control mg/kg • h/m$^2$ | Daily | Plant growing season | $CO_2$ in kg • per hectare | Dry weight c/ha | $CO_2$ kg/ha |
|---|---|---|---|---|---|---|---|---|
| | | | | $CO_2$ increase, mg | $CO_2$ from soil grams | | | |
| Legumes (beans, lentils) | | | | | | | | |
| 1 | Fertilizer-free control | 50.2 | - | - | - | - | 25 | - |
| 2 | Compost Absheron 10 t/ha | 82.3 | 32.1 | 770.4 | 115.5 | 1155 | 47 | 57.75 |
| 3 | Il Absheron channel 20 t/ha | 89.8 | 39.6 | 950.4 | 142.6 | 1426 | 58 | 71.3 |
| Vegetables (tomato, eggplant) | | | | | | | | |
| 1 | Fertilizer-free control | 226 | - | - | - | - | 42 | - |
| 2 | Compost Absheron 10 t/ha | 244 | 18 | 432 | 64.8 | 648 | 65 | 64.8 |
| 3 | Il Absheron channel 20 t/ha | 237 | 11 | 264 | 39.6 | 396 | 63 | 79.2 |

$CO_2$: Carbon dioxide

**Table 2:** A study of the effect of organic fertilizers on $CO_2$ emission under the conditions of irrigated gray-brown soil of Absheron under pepper culture for an average of 3 years

| No. | Options | $CO_2$ emitted mg/kg • h/m² | $CO_2$ is allocated per hectare during the growing season of pepper kg/ha | $CO_2$ increase compared to control without fertilizers | Dry weight of plants ц/га | Dry weight and yield | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Increase | | Harvest c\ha | Increase | |
| | | | | | | c/ha | % | | c/ha | % |
| 1. | The control | 45.9 | 198.5 | - | 275.2 | - | - | 69.3 | - | - |
| 2. | Rotted manure 20 t/ha | 82.0 | 353.0 | 155.8 | 473.2 | 198.0 | 73.2 | 117.3 | 42.6 | 60.6 |
| 3. | Partially rotted manure 20 t/ha | 80.3 | 347.0 | 148.4 | 437.5 | 162.3 | 60.5 | 104.0 | 32.0 | 42.0 |
| 4. | Fresh manure 20 t/ha | 78.4 | 338.8 | 140.2 | 358.3 | 116.5 | 43.7 | 93.3 | 21.3 | 30.3 |
| 5. | Compost Absheron 20 t/ha | 83.8 | 362.1 | 162.6 | 492.9 | 217.7 | 80.9 | 122.6 | 50.6 | 71.6 |
| 6. | Solid household waste 20 t/ha | 80.8 | 349.1 | 150.5 | 445.4 | 170.2 | 63.1 | 104.0 | 32.0 | 45.3 |
| 7. | Il Absheron 20 t/ha | 81.4 | 351.6 | 153.0 | 461.3 | 186.1 | 68.7 | 104.0 | 32.0 | 45.3 |

$CO_2$: Carbon dioxide

and the production of $CO_2$ from the soil. It was found that the higher the content of organic matter in the soil, the more it emits $CO_2$ under conditions of aeration and humidity, and the correlative high relationship confirms the contiguity and tightness between these parameters, where $P = +0.94+0.04$ (beans) and $P = +0.97+0.02$ (pepper).

## CONCLUSIONS

The introduction of various types and doses of organic fertilizers for legumes and peppers helps to increase the content of organic matter, nutrients (NPK), humus, carbon dioxide in the soil, as well as increase the growth and development of plants during different periods of vegetation.

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