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Evaluation of pre-crops and fertilization on organic zucchini under Mediterranean conditions: case of Turkey

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Abstract

Soil fertility is fundamental in determining the productivity of all farming systems. Major tools utilized in organic farming to increase the fertility of the soil can be expressed as rotation, green manuring and allowed organic fertilizers and soil amendments. A field experiment was conducted at Ege University in Izmir, Turkey, to study the effects of pre-crops used as green manure - including vetch, faba bean, broccoli and spontaneous weeds - and fertilization (compost tea, commercial fertilizer) on zucchini (the main crop in the rotation program) and on soil fertility. The main aim of the experiment was to identify the most suitable rotation program in organic farming for Turkey under prevailing conditions. Tested treatments had no marked effect on yield or quality of zucchini except inorganic matter content of the fruits. There were significant differences among tested pre-crops for N, P, K, OM and C values of the soil. Zucchini after broccoli fertilized with compost tea gave the highest gross margin due to the higher income derived from two different crops complemented with lower production costs compared to the commercial fertilizer.

Key words: Organic agriculture, soil fertility, crop rotation, green manure, organic fertilizers, zucchini, gross margin.

To my Family.
I couldn't do this without your
never-ending love and support.

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Abbreviations

C Compost or subplots fertilized with Compost (during previous years (2006-2007) experiment)

CT: Compost tea or subplots fertilized with compost tea

CF: Commercial fertilizer or subplots fertilized with commercial fertilizer

PT0: Soil sampling date for the experimental field before pre-crops of previous year's experiment on November 24, 2006

PT1: Soil sampling date after pre-crops before main crop of the previous year's experiment on May 02, 2007

T0: Soil sampling date after previous year's main crop (tomato) and before this year's pre-crops on September 26, 2007

T1: Soil sampling date after this year's pre-crops and before main crop (zucchini) on April 22, 2008

T2: Soil sampling date after this year's main crop (zucchini) on August 20, 2008

F: Fertilization treatments

P: Pre-crop treatments

Introduction

The foundation of organic farming lies in the health of the soil, a fertile soil provides essential nutrients to the growing plants and helps support a diverse and active biotic community (Vantine and Verlinden, 2003). This is one of the main differences of the organic agriculture from the other production systems. Where other agricultural systems try to feed the plant organic agriculture feeds the soil.

Organic agriculture feed the soil by different operations which have their main effects generally on the long term.

One of the practices is using green manure which has a great potential for increasing the availability of soil nitrogen to subsequent crop plants and for conserving nitrogen and enhancing the long term soil fertility and health (Ashraf *et al.*, 2004).

Another operation which has its effects on the long term is compost application. Compost is the best overall soil amendment growers can use to increase the quality and the health of soil (Postma *et al.*, 2003). Compost provides soil with nutrients, organic matter, and beneficial microorganisms, which can improve crop health, growth, quality, and yields. Compost also improves soil structure and long-term nutrients availability, which helps plants better tolerate drought and suppress disease (Rynk *et al.*, 1992).

Compos tea is another practice which has relatively faster and shorter effects than the other practices. Compost tea is described by Ingham (2002) as water extract of compost which contains soluble nutrients and diversity of bacteria, fungi, protozoa and nematodes. Compost tea can improve soil quality and health by increasing the number of beneficial soil organisms. Plants depend on soil microorganisms for gathering and incorporating nutrients in their roots. Compost tea contains substantial quantities of microorganisms added around the plant (Robson, 2000). These microorganisms also have the capability to suppress many serious plant diseases (Adams, 1990; Cook and Baker, 1983).

Organic agriculture developed through the guidance of practitioners. Research efforts were enhanced especially after 2000. In recent decades the interest shown in long-term experiments has increased worldwide, since suitable indicators of sustainable agriculture (yield trends, parameters characteristic of the quality of the ecosystem), capable of serving as an early warning system, can only be obtained in such experiments (Barnett *et al.*, 1995).

A common research strategy - coordinated by the Mediterranean Agronomic Institute of Bari in the framework of its Master program - was adopted by four institutes in four Mediterranean countries, Turkey, Italy, Tunisia and Morocco that foresees the development of agronomically, ecologically and economically suitable rotation programs. A four-year rotation program was initiated in 2006 parallelly in the 4 countries on an experimental station belonging to the institutions involved. In the second phase of the research, selected models will be tested for two years at farm level. Four year experimental plan for Turkey can be seen in table 1.

Table 1. 4 year experimental plan for Turkey

Pre-crops (for all the 4 year experimental plan)	Year	Main crop	Fertilization
1. Fallow 2. Faba bean 3. Vetch 4. Broccoli	1st year 2006-2007	Tomato	C+CT
			C
	2nd year 2007-2008	Zucchini	C+CT
			C +CF
	3rd year 2008-2009	Melon	C+CT
			C +CF
	4th year 2009-2010	Eggplant	C+CT
			C +CF

Another topic studied in the experiment as a secondary factor is the fertilization strategy. So, there were eight treatments which consist of four pre-crops (fallow, faba bean, vetch and broccoli) as the main factor and two fertilization strategies (compost tea and commercial fertilizer) as the secondary factor.

Objectives

General aim of this common research program is to test and finally recommend sustainable rotation models which are economically and technically feasible for Mediterranean conditions.

In the second year's rotation plan, the attempt was to analyze the most suitable crop rotation model for open field zucchini production under organic management conditions in Izmir, Turkey.

The specific objectives were:

- To study the effects of the treatments on soil fertility, plant nutrition and soil respiration.
- To study the effects of the treatments on weed, pest and disease incidence.
- To study the effects of the tested treatments on plant growth and crop yield and quality of zucchini.
- Economical comparison of the effects of the treatments on organic production (pre-crop and zucchini production cycles) as regard of gross margin.

Chapter 1

Literature review

1. Soil fertility

Fertility is fundamental in determining the productivity of all farming systems. Soil fertility is most commonly defined in terms of the ability of a soil to supply nutrients to crops. It is more helpful to view soil fertility as an ecosystem concept integrating the diverse soil functions, including nutrient supply, which promote plant production. This broader definition is appropriate to organic farming, as organic farming recognizes the complex relationships that exist between different system components and that the sustainability of the system is dependent upon the functioning of a whole integrated and inter-related system (Watson *et al.*, 2002).

Koopmans and Smeding (2008) state that learning how to manage beneficial soil biological processes as the key step towards developing sustainable agricultural systems. In this respect, they identify soil fertility (nutrients, structure and disease suppression), resistance and adaptations (resistance against stress and flexibility), buffer (organic matter, ability for self cleaning, water retention and climate function) and biodiversity as soil services. Soil services are linked with the management practiced by the farmer. Soil management affects soil life (biodiversity) directly and soil with the presence of roots, on the other hand has an indirect effect. All the management lead to soil services which finally affect productivity and the time required to reach the effect.

In a research aiming at searching the effect of tomato mixtures, two sets of environmental conditions, winter fallow and mustard cover crop were tested. Vegetative growth of all mixtures was better in winter fallow plots as revealed in aboveground biomass and canopy light interception. This result appeared due to higher availability of inorganic N in winter fallow plots. N availability was decreased from prior to cover crop incorporation to tomato harvest in winter mustard plots possibly due to higher soil microbial biomass (and initial CO_2 emissions) which suggested higher microbial activity. In the last two samplings, CO_2 emissions were higher in tomato plots following fallow (Barrios Masias and Jackson, 2008).

2. Crop rotation

A simple definition of crop rotation is the planting of different crops in recurring succession in the same field. Annual forage legumes can be important components of sustainable crop rotations in organic production systems (Heichel and Barnes, 1984; Hesterman, 1988).

Organic agriculture is a management technique that leads to food and environmental safety and sustainability. These aspects are realized only if basic principles of organic agriculture are met. Rotation is one of the major tools used in organic agriculture. The rotation program must maintain soil fertility, soil organic matter levels and soil structure and minimize nutrient losses, weed, pest and disease problems. A good rotation program must ensure to attain all these objectives and balance agricultural and ecological elements with economic considerations (Lampkin, 1994). Organic rotations are divided into phases that increase the level of soil nitrogen and phases that deplete it (Altieri, 1995).

One of the most important methods to guarantee high and constant yield with minimum external inputs in organic agriculture is to plant legumes. Legumes improve soil characteristics and fixes nitrogen (Köpke, 1996).

Legumes make an important contribution to plant nutrition by fixing nitrogen and improving soil characteristics. Main streams of nitrogen flow are fixed in the long term by organizing and optimizing the site-adapted crop rotation. It is considered one of the most important technological methods in organic agriculture to guarantee high and constant yields with the minimum reliance on external inputs (Köpke, 1996).

In a study done on corn soybeans rotation, corn yield following soybeans was 5 to 20 percent more than continuous corn on the same farm (Roth, 1996). Moreover, Burket *et al.* (2003) reported that broccoli grown with no nitrogen fertilizer after legume containing winter cover crops had a 50% higher average yield than that of fallow or cereal rye plots. Thus, the use of legumes cover crops showed that nitrogen fertilizer for broccoli can be reduced by 138 kg ha^{-1} compared to winter fallow or non-legume cover crop.

2.1. Green manuring

Growing green manure as a part of a crop rotation is an important part of organic farming systems. Green manures are plants grown to accumulate nutrients for the main crop. When they have built up maximum biomass (while green, or soon after flowering (Diver, 1999)), green manure plants are dug into the soil and at this point, they release nutrients and become fully decomposed within a short period of time (Eyhorn *et al.,* 2004).

The green manure must be ready to be incorporated before the next crop is sown. There should not be a long gap between digging in the green manure and planting the next crop. This is to prevent nutrients from the green manure leaching out of the soil before being taken up by the next crop (HDRA, 1998). The time gap should not be longer than 2 to 3 weeks and green manure should not be ploughed deeply into the soil but only worked into the surface soil (Eyhorn *et al.*, 2004).

Legumes applied as green manure remain as an important source of nitrogen in many crop production systems (Janzen and Radder, 1989; Becker *et al.*, 1995). Winter annual legumes have been used as green manure for centuries (Semple, 1928). One fact to be considered is that benefits of green manures occur over the long term and are not always visible immediately (Eyhorn *et al.*, 2004)**.** They do not only serve as a direct source of plant available nitrogen, but also have a great potential for increasing the availability of soil nitrogen to subsequent crop plants, for conserving nitrogen and enhancing the long term soil fertility (Ashraf *et al.*, 2004). Legumes are also known to increase the mineralization of soil native nitrogen which might be an important mechanism through which green manures enhance soil productivity (Fox *et al.*,1990).

Caporali *et al* (2004) reported that the amount of nitrogen contributed by the green manure depended upon the species and the weather trend that determine vigour and duration of the green manure growth cycle. He stated that the non-leguminous green manure had a little effect on subsequent maize yield and grain and straw nitrogen accumulation, compared to green manuring by leguminous. Weed growth in maize was also affected by cover crop green manuring, and their aboveground biomass and density were lower with the selected cover crops than the control treatment. These results suggest that legume green manuring can allow good yield of maize besides helping a successful weed control.

Vetch (*Vicia sativa*) and faba bean (*Vicia faba*) were tested as green manures in organic cotton production in clay loam soil (Athens, Greece) in 2005 and 2006. In both years, root formation was promoted as root dry matter, root length density, root diameter and root surface area in plots where vetch was incorporated. Results show no significant effect of green manuring on yield (Thomopoulos, 2008).

3. Soil respiration

Carbon dioxide emissions from soils (i.e., soil respiration) exceed all other terrestrial-atmospheric carbon exchanges with the exception of gross photosynthesis (Raich and Schlesinger, 1992). Almost 10% of the atmosphere's CO_2 passes through soils each year (Raich and Potter, 1995); this is more than 10 times the CO_2 released from burning fossil fuels. Due to the magnitude of this soil-to-atmosphere CO_2 flux and the large pool of potentially mineralizable C in soils (e.g., Bohn 1982; Eswaran *et al.,* 1993, 1995), any increases in soil CO_2 emissions in response to environmental change has the potential to exacerbate increasing atmospheric CO_2 levels and to provide a positive feedback to global warming (Schleser 1982; Jenkinson *et al.*, 1991; Raich and Schlesinger, 1992; Kirschbaum 1995). Identifying the environmental factors that control soil CO_2 emissions, and their effects on emission rates, is a necessary step in assessing the potential impacts of environmental change (James and Tufekcioglu, 2000).

Mayer et al (2008) measured soil respiration in control and effective microorganisms (EM) applied plots and found no effect of EM; however, the effects of sampling time (spring and autumn) was more pronounced compared to the effect of treatments.

Rotation design modifies both the size and activity of the soil microbial biomass. Indicators of biomass activity such as basal respiration and enzymatic activity suggest that there is a more active microbial biomass associated with grass-clover leys than with arable cropping which is in turn linked to the decomposition of organic matter and nutrient mineralization (Haynes, 1999).

Analysis has proven the important dependency of basal respiration to the moisture, bulk density and total nitrogen. Thus, the supply of organic matter to the soil environment greatly influences the soil respiration. Similar dependences were visible in the results obtained from both conventional and organic farming on arable land (Sarapatka *et al.*, 2006).

The results indicated that soil respiration was not enhanced by disk harrowing and that the yield effect of disk harrowing was mainly caused by quicker availability and better synchrony between N mineralization and plant uptake due to earlier start of decomposition (Eriksen *et al*., 2001).

A long term comparison trial was done by Fliessbach *et al.* (2007) to determine the differences between livestock based organic (BIOORG), bio-dynamic (BIODYN) and integrated farming systems (CONFYM) another integrated farming system fertilized with mineral fertilizers exclusively (CONMIN) and one control treatment remained unfertilized (NOFERT). The following results were obtained in the experiments: Soil basal respiration did not differ between farming systems at the same intensity, but when related to microbial biomass (qCO_2), it was 20% higher in CONFYM soils and 52% higher in CONMIN as compared to BIODYN, suggesting a higher maintenance requirement of microbial biomass in soils of the integrated systems. The manure based farming systems of the trial are likely to favor an active and fertile soil. Both, organic C and biological soil quality indicators were clearly depending on the quantity and quality of the applied manure types, but soil microbial biomass and activities were much more affected than organic C.

In a literature review, James and Tufekcioglu (2000) suggest that factors such as temperature, moisture availability, and substrate properties that simultaneously influence the production and consumption of organic matter are more important in controlling the overall rate of soil respiration than vegetation type in most cases. However, coniferous forests had ~10% lower rates of soil respiration than did adjacent broad-leaved forests growing on the same soil type, and grasslands had, on average, ~2 0% higher soil respiration rates than did comparable forest stands, demonstrating that vegetation type does in some cases significantly affect rates of soil respiration.

4. Fertilization program

4.1. Compost

Compost represents organic decomposed remnants. The remnants are either animal or vegetable, and are used for agriculture and gardening purposes. Natural decomposing takes a lot of time, so people have created a natural method to increase decomposing of organic remains, through a process called composting. These remains need a proper environment containing nitrogen, oxygen, carbon and water. In these conditions they can decompose creating the compost needed for soil enrichment (Stoffella *et al.*, 1996). Generally, proper conditions for active composting include an adequate supply of oxygen for microbial respiration (approximately 5% of the pore space in the starting material should contain air), a moisture content between 40 and 65%, particle sizes of approximately 0.32 to 5 cm in diameter, and a C:N ratio between 20:1 and 40:1 (Rynk *et al.*, 1992).

Composition of compost is generally not stable and mineralization of organic matter in the soil is determined by many factors as temperature, moisture, soil chemistry and microbial communities therefore the prediction of nutrient supply at a specific time period is generally hard (Owen *et al.*, 2008).

Compost application methods, placement, and rates for vegetable crop production systems are dependent on the crop grown, desired effect, and expected beneficial duration. Rates can vary from 25 to more than 250 $t.ha^{-1}$ of material with N contents up to 4% (Stoffella *et al.*, 1996). As compost decomposes in the soil, nutrients are released slowly. Compost generally will not supply all the nutrients required for optimum growth, but usually supplies most of the plant micronutrients (Schoneweis, 2005).

The other advantages of composting include suppression of pathogens and weed seeds, and improving handling characteristics of manure by reducing its volume and weight. Composting also has some disadvantages, including nutrient and C loss: 20 to 40% loss of total N and 46 to 62% loss of total C during the process, as well as significant losses of K and Na (6.5% of total K and Na), the cost of land, equipment and labour required, and odour associated with composting (Eghball and Power, 1999).

Compost is the best overall soil amendment growers can use to increase the quality and the health of soil (Postma *et al.*, 2003). Good compost provides soil with nutrients, organic matter, and beneficial microorganisms which can improve crop health, growth, quality, and yields. Compost also improves soil structure and long-term nutrient availability, which helps plants better tolerate drought and suppress disease (Rynk *et al.*, 1992). In addition, compost induces benefits in soil bulk density, macro-porosity, oxygen diffusion rate, shear vane strength and water-filled pore space (Carter *et al.*, 2004). Compost amendment significantly increases soil moisture by 7 to 10% (Edwards *et al.*, 2000) and water holding capacity (Lynch *et al.*, 2005).

Compost applied as a soil amendment can improve soil organic matter content, nutrient retention in soils susceptible to leaching, and stabilize soil pH. Moreover, composts are sources of macro and micronutrients, when compared to compost use in temperate climates, however, the benefits can be reduced in hot humid climates because organic matter decomposition is accelerated (Stoffella *et al.*, 1996). In addition, soil application of compost provides an alternative to current methods of waste disposal, and at the same time may decrease the amount of water and fertilizer applied to crops (Ozores-Hampton *et al.*, 1994).

High quality composts positively act on the structure of the ground (Abdelhamid *et al.*, 2004), its ventilation, its water holding capacity and the mineralization of the fertilizing elements (Porter *et al.*, 1999; Bailey and Lazarovits, 2003; Fuchs, 2003). The improvement of the structure of the ground allows a reduction of the erosion (Fuchs, 2003). One study conducted showed that compost application reduced soil loss by 86% compared to bare soils, and sediments reaching nearby surface waters decreased by 99% (Risse and Faucette, 2001).

A three year multi-site experiment was designed in New Brunswick, Canada to compare fertility in organic vs. conventional farming systems. The organic treatment comprised of two rates (low and high) of compost application compared to synthetic nitrogen. Three cropping systems, continuous beans, beans-rye-beans and rye-beans-rye rotations were tested. The results showed that nutrient supply was more affected by year than any other tested factor. Application of high compost rate increased Ca and K supplies but no other significant results were achieved. Synthetic N fertilization was similar to low compost level (Owen *et al.*, 2008).

A study conducted by Antler (2000) on barley and wheat cereal crops showed that addition of compost helped to improve soil physical properties. However, the effects on soil physical properties differed among tested composts (duck manure, sawdust, dairy manure or paper mill sludge bark) and their subsequent effects on growth were species specific (Gonzalez and Cooperband, 2002).

4.2. Compost tea

Compost tea describes many different preparations made using compost as a starting material and producing a liquid extract or in some cases a “liquid version” of the original compost (Bess, 2000). Ingham (2002) described as water extract of compost that is actually brewed and contains soluble nutrients and diversity of bacteria, fungi, protozoa and nematodes is defined as compost tea. A primary reason for producing compost tea is to transfer microbial biomass, fine particulate organic matter, and soluble chemical components of compost into an aqueous phase that can be applied to plant surfaces and soils in ways not possible or economically feasible with solid compost (Ingham, 2002).

Compost tea quality depends on the quality of compost, quality of water, the material of the bag, aeration, brewing time, environmental conditions, and water-compost ratio (Ramadan, 2006).

In fact, Scheuerell (2002) demonstrated that compost source had a greater effect on activity of the tea than aeration did. Raw materials or source of compost is the major factor affecting compost tea quality (Diver, 2002).

Compost tea can be applied through the fertigation system because it can give the opportunity to derive sufficient nutrient value of compost application (Sebti, 2005). Compost tea can improve soil quality by increasing the number of beneficial soil organisms. Plants depend on soil microorganisms for gathering and incorporating nutrients in their roots. Compost teas contain substantial quantities of microorganisms added around the plant roots (Robson, 2000).

The use of compost extracts presents a simple, inexpensive and potentially effective method to supplement on-farm disease management (Welke, 2001). It is demonstrated that animal manure-based compost gave better results as a plant protection agent than compost made from only plant material. Compost quality determines how large a diversity of beneficial organisms will be present (Ingham, 2002).

It is well known that certain soil microbes have the capacity to suppress many serious plant diseases (Adams, 1990; Cook and Baker, 1983). The disease-suppressiveness is a characteristic of organic tea, which was reported as early as 1973 by Hunt, *et al.* who showed that organic tea could be used as a foliar spray to inhibit Phytophthora on tomatoes and potatoes.

Farmers and gardeners are becoming more interested in mixing and soaking plant wastes, manures and composts in water, and used the rich decanted brew as a liquid fertilizer, or "organic tea”. Compost teas are applied to soil or to plant foliage. Compost tea applied to soil will move into root zone and affect the rhizosphere, where nutrient carried by the tea will be used by plant as well the organisms in soil. Tea sprayed to leaf will typically alter the set of organisms on foliage through both inoculation of the organisms from the tea and through supply on nutrient that help support survival of leaf colonizing organisms (Ingham, 2002).

5. Information about tested crops

5.1. *Vicia faba* cv. *Sevilla* (Faba bean)

Faba bean is a coarse, erect, glabrous, very leafy annual plant which can reach 50 to 200 cm heights (Hermann, 1960). The flower is white with a black spot on each wing and is borne in sessile axillary racemes. (Madson 1951). Faba bean (cv 'Fiord') at maturity is reported to contain 50% of total dry matter and 78% (90 $kg.ha^{-1}$) of total nitrogen in the seed, 30 $kg.ha^{-1}$ in the stubble, and 6-8% of the N fixed (less than 15 kg $N.ha^{-1}$) in the root system (Herdina and Silsbury, 1990).

5.1.1. Temperature requirement

Faba bean is adapted to a cool, temperate climate (McLeod, 1982) and does not endure heat (Duke, 1981; McLeod, 1982). High temperatures curtail seed production, and it cannot be grown where temperatures fluctuate rapidly (McLeod, 1982). Though mentioned as resistant to frost injury, with hardier varieties surviving temperatures as low as -10^{o}C without serious damage (Duke, 1981), it is more susceptible to low temperatures than the vetches (Miller, 1988).

5.1.2. Water requirement

Faba bean tolerates a wide variety of drainage conditions (Peaceful Valley, 1988) but will not tolerate drought (Duke, 1981; Pears *et al.* 1989; Husain *et al.* 1990), which at flowering or pod formation can cause severe reduction of seed yields (Koscielniak *et al.*, 1989). Faba bean can be grown from 230-2090 mm of precipitation (Duke, 1981).

5.1.3. Soil requirement

Faba bean tolerates a wide variety of soils (Peaceful Valley, 1988), doing well in loam to clay soils (Madson, 1951; Munoz & Graves, 1988), and best in well drained, heavy silt or clay loams with large quantities of humus and calcium. Pears *et al.* (1989) cite that it does best on heavy soils, whereas Duke (1981) mentions that it performs best on rich loam soils.

5.1.4. Life cycle

Faba bean has been regarded as a spring (Munoz & Graves, 1988) or as a winter annual (McLeod, 1982). Faba bean plant is stiff-stemmed and tall (Miller, 1988), stemmy, and with moderate to heavy density of growth (Madson, 1951).

Buttery and Gibson (1990) indicated that substantial N-fixation of faba beans continues up to plant maturity, whereas N-fixation by pea reaches a maximum before or at flowering and drops during pod formation.

5.1.5. Incorporation

Faba bean adds a large amount of organic matter to the soil when turned in as green manure (McLeod, 1982). The best time for incorporation is at blossom (McLeod, 1982; Munoz and Graves, 1988). The vegetation will decompose more rapidly if the plants are succulent, but in general, faba bean residue persists longer than that of other leguminous cover crops, which can help improve heavy soils (Miller, 1988). Duke's (1981) says that faba beans produce 4,870-8,060 kg.ha^{-1} of dry matter.

5.1.6. N Contribution

Estimated amount of N fixed may range from 56.1-224.1 kg.ha^{-1}, but faba bean is regarded as a low nitrogen fixer (Munoz & Graves, 1988). In six weeks of growth, faba bean may fix up to 112.2 kg N.ha^{-1} (McLeod, 1982). Faba bean has a lower N content in above-ground biomass than most other legume cover crops.

5.1.7. Weed control

Faba bean is not good at suppressing weeds and must be sown densely to avoid weed problems (Pears *et al.*, 1989) and soil cultivation is often required (Duke, 1981).

5.1.8. Pest and Diseases

Peaceful Valley (1988) suggested that beneficial insects do well on the numerous blossoms, but extra floral nectaries appearing as dark spots on the stipules are probably more important (Bugg, 1996).

Faba bean is regarded as more susceptible to aphid infestations than the vetches (Miller, 1988); in particular, it is attacked by bean aphid (*Aphis fabae* L.) which seldom affects its use as a cover crop but often interferes with the production of seed (Madson, 1951).

Faba beans are frequently attacked by bacterial blast. It forms black lesions in cold damp weather especially on the stems. Observations in a Sonoma County field for forage production showed a 30% loss of the stand due to this disease.

5.2. *Vicia sativa* (Common Vetch)

Common vetch is widely used as a soil-improving cover crop or green manure. Common vetch is said to tolerate frost, fungal infection, grazing, high and low pH, insects, nematodes, virus, and weeds. Being insect pollinated its seed production benefits from nearby bee hives (Duke, 1981).

5.2.1. Temperature requirement

Goar (1934) stated that common vetch will withstand temperatures as low as 12 C below zero with little or no injury. Since it quickly succumbs in hot weather, it should be planted in the fall and harvested in the spring. Its rate of growth during the winter months is intermediate.

5.2.2. Water requirement

Common vetch tolerates a wide range of rainfall from 310 to 1630 mm of precipitation (Duke 1981).

5.2.3. Soil requirement

Goar (1934) stated that common vetch is adapted to a wide range of soil conditions, doing best on the fine-textured clay and clay-loam soils. Common vetch tolerates pH of from 4.5-8.2, with the mean for; excess lime is injurious. It is said to be tolerant of low pH (Duke, 1981).

5.2.4. Incorporation

As a green manure, common vetch is easily incorporated using disk harrow; presumably, full flower is the proper phenological stage for plow-down (Duke 1981).

5.2.5. N contribution

Aboveground nitrogen content of common vetch was 134 kg.ha^{-1} in the study performed by Smith *et al.* (1987); estimated N fertilizer equivalence of common vetch under no-tillage regimes was, when followed by sorghum, 30-83 kg/ha.

5.2.6. Weeds

Schenk and Werner (1991) stated that various legumes in the tribe Vicieae (peas, lentils, and vetches) contain Beta-(3-isoxazolinonyl) alanine, which is released into soil as a root exudate and apparently is an allelopathic compound.

5.2.7. Pests

Common vetch harbors pea aphid (*Acyrthosiphon pisum* and cowpea aphid (*Aphis craccivora*) and has extra floral nectaries (on the stipules) that attract various beneficial predatory and parasitic insects, as well as certain pests, like *Lygus hesperus* (Bugg *et al.*, 1989).

In southern Georgia, blackpod or narrowleaf vetch (*Vicia angustifolia* or *Vicia sativa* ssp. nigra) grows in the understories of pecan orchards and can harbor substantial densities of pea aphid (*Acyrthosiphon pisum*) and cowpea aphid (*Aphis craccivora*) and associated lady beetles. This situation may prove useful in efforts to enhance biological control in pecans (Bugg *et al.*, 1989).

5.3. *Brassica oleracea* var. *italica* (broccoli)

Broccoli is a member of the cabbage family. Broccoli was developed from leafy Brassica forms, commonly known as "Calabrese broccoli," found in the northeastern Mediterranean and southern Europe (Wayne *et al.*, 1998).

5.3.1. Soil and water requirement

Broccoli grows best on well-drained, fertile soils. If possible, avoid heavy, stiff soils and very light, sandy soils. Follow a three to four year rotation including a cover crop to provide a good supply of organic matter. pH is a very important factor in reaching optimum broccoli yields (Wayne *et al.*, 1998). Snaders (2001) suggests that soil pH should be 6.0 to 6.5 but also suggests that organic soils do not require such a high pH.

To fulfill water requirement of broccoli, be prepared to irrigate 1 to 1 1/2 inches of water per week if natural rainfall is lacking to help ensure a high-quality broccoli crop. Broccoli requires above average moisture, and when this is lacking it responds with slow growth and poor appearance.

5.3.2. Temperature

Broccoli is a cool-season vegetable that prefers average temperatures of 18° to 25°C for best growth. Cole crops will “bolt” or produce a flower stalk if exposed to a prolonged cold period of 10 or more continuous days of temperatures between 2° and 10°C following a favorable growing period. The larger the plants are at the time of exposure to the cold period, the higher the incidence of bolting. However, sensitivity to bolting depends on the variety. When planted in the spring, broccoli must be planted early enough to ensure that it is harvested before temperatures become too hot (Smith and Doubrava, 2003).

5.3.3. Planting

Yield of broccoli and size of head are affected by plant spacing and density. A greater number of plants per acre increases yields, but size and weight per head are decreased. Plants should be set 20 to 35cm apart on the row and 65 to 90 cm apart between the rows (Wayne *et al.*, 1998).

5.3.4. Harvest and storage

Broccoli is ready to harvest 65 to 70 days after planting transplants. Harvest broccoli when the main head is 7 to 15 cm in diameter and the flower buds are still tightly closed. Cut the main stem about 15 cm below the top of the head (Smith and Doubrava, 2003). Spring broccoli should be harvested in the early morning, because it wilts very rapidly in the sun. Field crates or baskets should be immediately removed to a packing shelter where it is bunched and iced. The broccoli head should be cut before the flower buds open (Snaders, 2001). A few days after the central head is cut, small lateral, or side, shoots grow out and produce small heads measuring 1 to 3 inches in diameter. These side shoots are seldom of the quality for commercial sale. Small heads produced by the side shoots are very desirable for freezing and use in the home (Snaders, 2001). Broccoli can be stored in perforated plastic bags for up to a week in the refrigerator and any surplus can be deep-frozen (Smith and Doubrava, 2003).

5.3.5. Pests and diseases

Caterpillars are usually more injurious to the young plant, although they will feed on broccoli until harvest. They include the cabbage lopper, cabbage worm, and diamond back moth. The female flies from plant to plant laying eggs on the leaves. The eggs hatch in three to five days and the young worms begin feeding. During this stage caterpillars are easiest to control with permitted applications. Once the worms reach 1,5cm in length, they are more difficult to control. Most caterpillars have a similar life cycle and cause similar damage (Wayne *et al.*, 1998). The severity of insect attack is much greater in fall crops (Snaders, 2001).

Diseases do not usually cause serious damage to broccoli. The exceptions are such diseases as black rot which may spread from cabbage or related crops or weeds, and may also be carried on seeds. Powdery and downy mildew are often found but only rarely are they a serious problem. Alternaria leaf spot may also be found on broccoli. Soft rot can be serious in years of high precipitation; domed heads with certain varieties will help reduce this disease (Snaders, 2001).

Most serious broccoli diseases can be introduced to a clean field on diseased transplants. Therefore, it is imperative that a grower plant disease free transplants. Growers can avoid two of the most serious diseases, black rot and black leg by purchasing certified transplants or direct seeding only seed certified free of black rot and black leg (Wayne *et al.*, 1998).

5.4. *Cucurbita pepo* L. (Zucchini)

Zucchini (*Cucurbita pepo* L.) is a member of Cucurbitaceae family which is comprising about 90 genera and 700 species and considered as a medium-sized plant family, primarily found in the warmer regions of the world (Andres, 2004). Cucurbits are herbaceous, frost-sensitive, trailing, tendril-bearing vines, bearing large palmate leaves and prominent fruits. Most species of Cucurbits are mesophytes, have fibrous root systems, and are monoecious (the male and female flowers develop on the same plant), bearing large, intensely orange-yellow, nectar-producing, unisexual flowers that are foraged by bees. Cucurbita is one of the most economically important genera of vegetable crops, with three of its species being widely distributed in cultivation (Paris, 2000).

Cucurbits are usually climbing or trailing plants with leaves arranged alternately along the stem. Their leaves characteristically resemble hearts, kidneys or hand-prints, with three or more main veins (Schoneweis, 2005). During the main growing season, the ratio of male to female flowers is usually 3:1 or higher. The female flower is distinguished by the presence of an ovary in the base and they are born on very short stems while the male flowers born on long stems. Honey bees are the primary pollinators and 2,5-5 hives of bees should be provided for a good fruit set. Zucchini squash is green and straight. Poor pollination results in small young fruits that turn yellow shrivel and fall off. Incomplete pollination may also cause misshapen fruits that are unmarketable. Squash fruits grow about 1.9-2.5 cm per day (Molinar *et al.*, 2000).

Fruit diversity is quite astonishing, with shapes ranging from globosely to pear-shaped, elongated or flattened, with smooth, warted, ribbed or furrowed skin and colors from green, white and blue-grey to yellow, orange or red.

5.4.1. Temperature requirement

Zucchini is a frost-susceptible plant. The optimum temperature for seed germination is (23 – 25 C°), the minimum is (12 C°) (Durand and Dial, 1987). The zero of vegetation border is 10 C° and the optimum temperature 16-18 C°) the night and (20-25 C°) at the day (Nisen,1988). The temperatures lower than 10°C are harmful for the plant, especially during early stages (risk of necrosis and fall of flowers) (Ryal and Lipton, 1979) but the sensitivity to frost differs highly among the varieties (Suslow and Cantwell, 1998). The dehiscence of the anther can be carried out only under temperature higher than 12°C, the receptivity and fruit set can be blocked at high temperature and very low water content (Nisen, 1988).

5.4.2. Shade tolerance

Zucchini does not tolerate shading; a strong light intensity and long photoperiod support the appearance of female flowers, whereas a relatively short photoperiod supports the formation of male flowers (Nisen, 1988).

5.4.3. Root system

Zucchini roots develop rapidly, with roots in the top 45.5 cm of soil (Molinar *et al.*, 2000).

5.4.4. Soil requirement

Zucchini grows on a wide variety of soil types with proper management. In all cases, however, the soil should be well drained. Sufficient amount of nitrogen is needed to produce maximum summer squash yield. Previous crop history should also be considered when selecting a site (Boyhan *et al.*, 1999). The optimal pH is 5.8-7 (Molinar *et al.*, 2000).

5.4.5. Water requirement

Irrigation should be scheduled to avoid excessive moisture or water stress. Early season irrigation tend to cool the soil and slow plant growth. At least 1.854 m^3 is required for the season. Generally, 103 m^3 of water is applied each irrigation. Sandy soils require more frequent irrigations than clay soils. Lack of adequate moisture at harvest can result in misshapen fruits and too much moisture can aggravate root and stem rot diseases. Watering should be done regularly to have good harvest particularly in dry conditions (Molinar *et al.*, 2000).

5.5. Pest and diseases of zucchini

5.5.1. Viruses

Viruses are the most limiting factor in zucchini production, particularly during summer and fall months. There are several viruses that cause diseases in squash including cucumber mosaic virus, papaya ring spot virus Type W, watermelon mosaic virus and zucchini yellow mosaic virus. Fruit distortion can be seen across squash types. The use of resistant verities is the only reliable control for diseases caused by viruses (Roberts and Kucharek, 2007).

5.5.2. Squash bug (*Anasa tristis*)

The squash bug causes severe damage to cucurbits because it gives highly toxic saliva into the plant. The foliage is the primary site of feeding but the fruit is also fed upon. (Bonjour and Fargo, 1989).

The Tachnidfly (*Trichopoda pennipes*) attacks squash bugs and occurs naturally in the field. Although parasitism rates as high as 80 percent have been reported, the fly is still unable to control squash bug populations below economically damaging levels. The fly is not available commercially (Hitchner and Kuhar, 2005).

5.5.3. Silverleaf white fly (*Bemisia argentifolii*)

Silverleaf signs on squash leaves occur only on the upper surface, beginning as a lightening of the leaf veins. Veins begin to appear silver, and under severe infestations, the entire upper leaf surface eventually turns silver. Severe leaf silvering affects fruit quality, making yellow summer squash paler in color, zucchini squash light- to yellowish-green, acorn squash a mottled green or yellow, and golden acorn squash white (Stansly, 1995).

The use of pathogenic fungi is a potential alternative to control the silverleaf whitefly. Fungi that attack whitefly include the fungi *Ascersonia* spp, *Verticillium* spp, *Paecilomyces* spp, and *Beauveria* spp. (Osborne and Landa, 1992). These fungi are generally safe to organisms other than their hosts.

5.5.4. Aphids (*Aphis gossypi*)

Aphid feeding in the phloem causes direct plant damage. The saliva injected during feeding may cause the foliage to become twisted, curled, or cupped downward. A large aphid infestation may cause plants to gradually wilt, turn yellow or brown, and die. Indirect damage also occurs through the excretion of excess sugar as honeydew, which accumulates on the upper surfaces of leaves and supports the growth of sooty mold. In addition to the damage caused by feeding, aphids can transmit viruses. Several viruses common to cucurbit plants are cucumber mosaic virus, watermelon mosaic virus and zucchini yellow mosaic virus (Capinera, 2000).

In many countries, *Aphidoletes aphidimyza* (Rondani) and *Aphidius colemani* (Viereck) have been used effectively as a biological control agent against aphids (Harizanova and Ekbom, 1997). Natural enemies will help keep aphid populations in check but will be less effective in very hot weather when aphids reproduce rapidly (Boyhan *et al.*, 1999).

5.5.5. Phytophthora blight (*Phytophthora capsici*)

Early foliar symptoms include rapidly expanding, irregular, water-soaked lesions in leaves. Dieback of shoot tips, wilting, shoot rot, and plant death quickly follow initial infection. Sunken, dark, water-soaked areas appear in infected fruit, and are rapidly covered by white fungal growth. Given optimal warm, wet weather, *P. capsici* can devastate entire squash plantings in a matter of days (Babadoost, 2000).

Chae *et al.*, (2006) reported that compost sustaining a multitude of chitinase-producing bacteria used as a soil amendment in a greenhouse study could alleviate pathogenic effects of *P. capsici.*

5.5.6. Downy mildew (*Pseudoperonospora cubensis)*

Downy mildew is caused by the fungus *Pseudoperonospora cubensis* and is favored by moist conditions. It is one of the most important leaf diseases in cucurbits. Typically, symptoms begin as small yellow areas on the upper leaf surface. As lesions expand, they may become brown with irregular margins. Affected areas may grow together, and the entire leaf may wither and die. Infected plants also develop a gray mold on the lower leaf surface. The fruit is not affected but it will be less sweet (Boyhan *et al.*, 1999).

5.5.7. Powdery mildew (*Erysiphe cichoracearum*, *Sphaerotheca fuliginous*)

Early symptoms of powdery mildew are small, round, white spots on the lower surface of leaves and sometimes on stems. As the spots enlarge and merge, they can be seen on the upper leaf surface as a white powdery growth comprised principally of spores. Severe infestations can cause leaves to become first yellow, and then brown and dry. Yields are reduced as a result of foliage loss (Kristkova and Lebeda, 1999).

The hyperparasite *Ampelomyces quisqualis* can be used to control powdery mildew in cuccumber. Where the cucumber yield increased compared with untreated plants (Sundheim, 1982).

Some other control methods are:

- Vigorous indeterminate varieties may maintain sufficient numbers of healthy leaves to tolerate powdery mildew longer in the season.
- Sulfur, Mineral oil, plant oils, Potassium bicarbonate, *Bacillus subtilis*, or combinations of oil and potassium bicarbonate applications are effective for controlling the powdery mildew.

5.5.8. Gummy stem blight (Mycosphaerella citrullina)

Gummy stem blight symptoms can occur at any plant stage and on any above-ground plant part. Symptoms usually appear first at the crown, with brown lesions that eventually become white. On leaves, lesions are round or irregular in shape and brownish in color (Larson *et al.*, 2000).

Some control methods can be listed as avoid planting in fields with residual cucurbit crop debris still present and purchasing disease-free transplants (Larson *et al.*, 2000).

5.5.9. Root-knot nematode (*Meloidogyne* spp.)

Root-knot nematodes particularly *Meloidogyne* spp. are the most widely distributed nematode pathogen of squash.

Root-knot nematodes enter the host plant as second stage juveniles and settle within the root to establish a feeding site. At the feeding site, secretions from the nematode cause the surrounding plant cells to enlarge and multiply, producing the characteristic galls associated with root-knot attack. Root deformation results in symptoms that include stunting, wilting, chlorosis, and yield loss. Additionally, the gall tissue is more susceptible to secondary infections such as root rot (Hanna *et al.*, 1993)

Some of the biological control methods for specific root-knot nematode species can be used as the use of predatory nematode *Mononchoides fortidens* in suppressing the rot nematode *Meloidogyne aren*aria in potted field soil (Khan and Kim, 2005).

The effect that the chitin-enriched compost and broth harboring chitinolytic bacteria may be through attacking immature nematode eggs causing premature hatch, resulting in nematode mortality and a decrease in the population of *Meloidogyne incognita* (Siddiqui and Shaukat, 2002).

The two rhizobacteria *Pseudomonas aeruginosa* strain IE-6Sþ and *P. fluorescens* strain CHA0 used as bare root-dip treatment or as soil drench substantially reduced *Meloidogyne javanica* juvenile penetration into plant roots under glasshouse conditions (Siddiqui and Shaukat, 2002).

Chapter 2

Material and methods

1. Experimental site

1.1. Farm location and history

The study was carried out at the experimental field of Faculty of Agriculture, Horticulture Department, and Ege University Campus in Izmir / Turkey. The site is 40 m above the sea level and located at Latitude: $38^0$27`15.4`` N and Longitude: $27^0$13`26.3`` E (GPS, Garmin 12). A general view of the experimental field can be seen in figure 1.

Figure 1. General view of the experimental field.

Prior to the experiment, the field was a cherry collection orchard. No fertilizers or pesticides were applied to the plot since 2002. The trees were uprooted in 2005 and the long-term experiment was initiated in 2006.

During the first year of the experiment in 2006-2007, performance of *Vicia sativa* (vetch), *Brassica oleracea* var. *italica* (broccoli), *Vicia faba* (faba bean) and fallow were tested as preceding crops and tomato cv. Porsuk was evaluated as the main crop under two fertilization strategies (Nazik, 2007).

1.2. Climatic conditions

The region is characterized by a Mediterranean climate with dry summers followed by long rainy season. Precipitations in Izmir are distributed as follows: 22% in spring, 2% in summer, 21% in autumn and 55% in winter. The average rainfall is reported by The Turkish State Meteorological Service as 689 mm the last 70 years, and 745 mm in 2006, 478 mm in 2007 and 166,7 mm till the end of August in 2008 (Table 2).

Table 2. Monthly rainfall for years 2006, 2007 and 2008 (mm)

	Rainfall (mm)		
	2006	**2007**	**2008**
January	77.5	33.1	30.1
February	93.4	22.6	9
March	180.9	29.7	60
April	29.4	19.3	62.3
May	0.2	44.1	4.9
June	10	0.3	0.4
July	0	0	0
August	0	0	0
September	167.2	0	-
October	114	107.7	-
November	63.1	111.6	-
December	29.4	118.8	-

A data logger (Hobo, Inc.) was placed within the experimental field to record hourly air temperature and relative humidity.

1.1. Soil properties

According to the results of the analysis at T0 (sampling done before pre-crops), the texture of the soil is loamy. Soil pH is 7.56 and salinity is 0.034. The soil is rich in potassium, poor in nitrogen and phosphorus, high in calcium, iron, magnesium and zinc and adequate in copper and manganese. Soil properties can be seen on table 3.

Table 3. Soil properties for T0 and standard values.

Soil property	**Standard value**	**T0 value**
pH	6.5 – 7.5	7.56
Soil texture	Loamy	Loamy
Salinity		0.34
OM (%)	1 – 1.5	2.82
C (%)	0.5 – 0.9	1.63
Total nitrogen (%)	1 – 1.2	0.12
P_2O_5 (ppm)	25 - 100	6.29

K (ppm)		351.56
Calcium carbonate (%)	1 – 5	2.22
Fe (ppm)		5.96
Mg (ppm)		600
Mn (ppm)		5.82
Cu (ppm)	230	0.94
Zn (ppm)	500	11.1

1.2. Experimental design

The experimental design is a split-plot design with four replicates and two factors.

Main factor: Effects of pre-crops (faba bean as commercial legume, common vetch as legume to be incorporated and broccoli as farmers' choice compared to weeded fallow as control) and

Second factor: Fertilization type: Compost tea application (CT) and commercial organic fertilizer (CF).

Each sub-plot is 30 cm^2 and the distance between sub-plots is left as 1m to create a buffer zone (Figure 2).

All the pre-crops have been incorporated after their growth. A commercial compost brand named Bioaktif has been used for compost tea applications and Powhumus as commercial fertilizer.

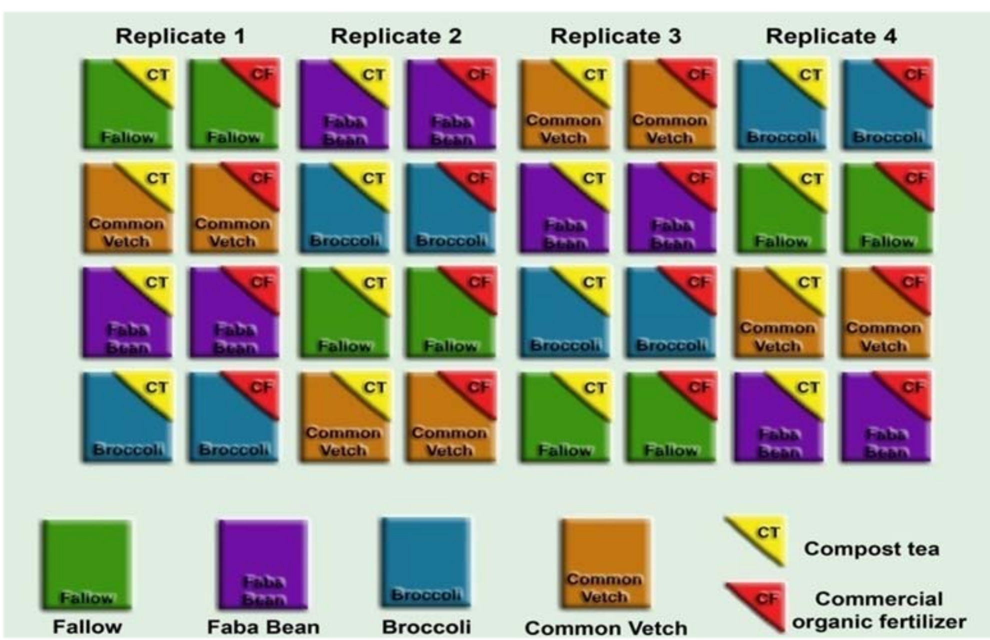

Figure 2. Experimental design for pre-crops

1.3. Cultural practices

All the soil-related cultural practices were kept at minimal level not to disturb the soil fauna. One disk harrowing was done before the pre-crops to prepare the field on August 28, 2007. On December 07, 2007 plowing and on December 25, 2007 disk harrowing were performed to the field - except the broccoli plots - to prepare the soil for seeding faba bean and vetch. To incorporate the pre-crops and prepare the soil for zucchini seeding, soil was ploughed on May 6, 2008 and disk harrowed on May 7, 2008. After the zucchini production, soil was disk harrowed on August 11, 2008, to incorporate the zucchini plants.

1.3.1. Irrigation

The experimental plots were irrigated by a drip irrigation system in order to have homogeneity in water distribution.

During the pre-crop growth cycle broccoli plants were irrigated only once. 1.2m^3 of water is used for this irrigation. Other plots were not irrigated as there was enough rain during the vegetation period of pre-crops.

During zucchini production, the field was irrigated regularly from May 9, 2008 to August 9, 2008. Total amount of water applied is calculated as 297.6m^3.

1.3.2. Plant Protection

Weed control was done by hoeing to minimize the adverse effect on soil fauna, and to minimize the carbon emission. Weeding was done twice for the broccoli plots on September 21, 2007 and October 15, 2007. Faba bean plots were weeded only once on March 28, 2008. Zucchini plots were weeded 4 times on May 22, June 5, June 28, and July 17, 2008.

For pest and disease control, preparations permitted in organic agriculture were used when necessary as mentioned in table 4.

Table 4. Plant protection measures applied for zucchini production.

Date	Targeted organism	Application	Concentration
May 20, 2008	White fly	Neemazal	2,5ml / 10lt
May 29, 2008	White fly	Neemazal	2,5ml / 10lt
June 25,2008	Red mite	Sulphur (wetable powder)	500gr / 100lt

2. Plant material

2.1. Pre-crops

Three pre-crops were used for soil building: Faba bean (*Vicia faba*) as commercial legume, common vetch (*Vicia sativa*) as incorporated legume and broccoli (*Brassica oleracea* var. *italica)* as farmers' choice. The fourth variable was fallow.

Untreated conventional faba bean and broccoli seeds were provided by Antalya Tarim Seed Company and broccoli seedlings were raised by Ege Fide, a subsidiary of Antalya Tarim in Torbali/Izmir. Organic vetch seeds were provided from Isik Company. Common vetch and faba bean seeds were directly sown on December 26, 2007 and broccoli seedlings were transplanted on September 15, 2007 to the field.

Plant densities of the soil building crops were 12.5 g seed.m^{-2} for faba bean, 10 g seed.m^{-2} for common vetch and 4 seedlings.m^{-2} for broccoli. A fallow control where weeds were incorporated was used.

Natural vegetation in fallow subplots, vetch and broccoli were cut before the incorporation to improve the degradation process (Figure 3). The cutting of common vetch was done when 2/3 of the flowers were open on April 15, 2008. The cutting of the broccoli plants were done on April 4, 2008 after the end of the broccoli production. Faba bean was incorporated without cutting on May 6, 2008 with the other pre-crops and control (fallow). Pre-crops were incorporated into the soil first by chopping with a plough and then disk harrowing.

Figure 3. Cutting of vetch before incorporation.

2.1.1. *Vicia faba cv. Sevilla* (Faba bean)

Vicia faba cv. *Sevilla,* is an early variety, length of faba pod is between 12cm to 14cm, length of plant (Figure 4) is between 85 cm to 102 cm, plant grows vertically and fruit is light green and flat. Yield characteristics are reported as a high yielding faba bean variety and it can be grown where faba beans can grow.

Figure 4. Faba bean plants at an early growing stage.

Even faba bean was intended as commercial legume only two harvests were made on April 17, 2008 and April 24, 2008 due to the time constraint for the zucchini production.

2.1.2. *Vicia sativa* (Common Vetch)

Organic seeds were used to produce vetch (Figure 5) which were provided locally from an organic farm in Izmir, and the propagated seeds are not from a registered variety.

Figure 5. Vetch plants at flowering stage.

2.1.3. *Brassica oleracea* var. *italica* (Broccoli)

Brassica oleracea var. *italica* is vigorous variety with a lifecycle of 70-75 days. Leaves and fruits are dark green in color. It has a round head and compact florets. Rather durable in the field.

Broccoli heads (Figure 6) and laterals were harvested on December 12, 2007; December 17, 2007; January 11, 2008; January 29, 2008; February 20, 2008; March 05, 2008; March 19, 2008.

Figure 6. A mature broccoli head.

2.2. Main crop (*Cucurbita pepo* L (Zucchini))

Untreated conventional zucchini seeds were provided by Neobi Seed Company. An open pollinated cultivar was sown directly to the field on May 08, 2008 after incorporation of the pre-crops. Seedlings were raised in case of low take ratio. On May 30, 2008 seedling were transplanted to fill the empty spots on the field so that every subplot has 40 zucchini plants. Harvests were done three times a week as every Mondays, Wednesdays and Fridays, beginning from June 21, 2008 till August 04, 2008. At the end of their life cycle, zucchini plants were incorporated into the soil on August 11, 2008 by disk harrowing.

3. Fertilization program

Nutrition of zucchini plants was maintained by applying commercial compost (Bioaktif) both as compost and compost tea and a commercial fertilizer (powhumus). The composition of compost (Bioaktif) is given in table 5.

Table 5. Composition of the compost (Bioaktif), produced by Camli Besi, Izmir, Turkey

Total nitrogen	3,5 %
Organic nitrogen	3%
Total P_2O_5	3%
Total soluble K_2O	3%
Total organic matter	60 %
Humidity	20 %
pH	7-8

Compost was hand distributed at a rate of 4,6 kg.subplot^{-1} to all the subplots on June 04, 2008 after nearly one month from the sowing of the zucchini seeds. Further to the compost application, different operations were done in CT and CF subplots. A total of 200 l CT extracted from 40 kg compost was applied for all CT subplots. CT is applied by drip irrigation on 5 different dates as June 30, July 7-14-21-27, 2008. After July 27, 2008 no more CT could be applied due to the problems that appeared in the fertigation system. For CF subplots a total of 750 g of Powhumus was applied on three different dates (July 07-14-21, 2008) with drip irrigation. Fertilization schedule is summarized in Table 6.

Table 6. Fertilization schedule

CT Subplots	CF Subplots
Hand distribution of 6 kg.subplot^{-1} compost on June 04, 2008 for both CT and CF	
200lt of compost tea applied to the CT subplots by drip irrigation on 5 different dates (June 30, 2008; July 7-14-21-27, 2008).	250 g Powhumus applied to CF subplots 3 times (July 07-14-21, 2008) by drip irrigation.

3.1. Compost tea

3.1.1. Compost tea preparation

Compost tea is prepared in plastic tanks in order to avoid any air contamination from insects or dust. Compost tea is prepared from the commercial compost under aerobic conditions according to the protocol stated below.

- Water compost ratio: 5:1 (v/v) as it was recommended for making extraction of compost according to the EU (Brinton *et al*, 2004),
- Aeration: Continuous aeration through an air pump used in aquariums,
- Temperature: 24^{o}C (± 5), recommended condition for micro organisms' growth,
- Duration of tea extraction: 3 days, applied directly without storing.

3.1.2. Content of compost tea

CT is analyzed to determine the chemical characteristics of the applied extract. Two representative samples were taken for chemical analysis and average values were calculated (Table 7).

Table 7. Macro nutrient composition of the compost tea

N (%)	P (ppm)	K (ppm)	Mg (ppm)	Na (ppm)
0.023	47.6	1640	78.1	544.3

3.2. Commercial fertilizer (Powhumus)

Powhumus is imported by IZOTAR Company (Izmir, Turkey) and is permitted for use in organic agriculture according to Annex II of regulation (EEC) 2092/11 and the Turkish regulation on organic agriculture. The composition of Powhumus is given in Table 8.

Table 8. Composition of the Powhumus (w/w).

Total Potassium humate	97%
Humic Acid	55%
Fulvic Acid	30%
Total soluble K_2O	12%
Iron (Fe)	1%
Total organic matter	82%
C/N Ratio	52:1
Humidity	14%
pH	8-9
Micro elements	1.2%

4. Sampling

4.1. Soil

Soil properties were analyzed in samples taken before planting/sowing soil building crops on September 26, 2007 (T0). Second sampling (T1) was supposed to be taken before planting the main crop and three weeks after incorporation of soil building crops, but to allow time for the main crop to complete the cycle; soil sampling was done on April 22, 2008 (T1) after the zucchini seeds were sown. As the zucchini seedlings' were newly initiating roots, soil sampling is done after sowing and between the zucchini rows. The third sampling was done after incorporation of zucchini residues on August 20, 2008 (T2). Samples are taken at 0-20 cm depth. For analysis at T0, T1 and T2 three samples were taken from each subplot following the ″V″ system.

Soil samples were analyzed at Ege University, Faculty of Agriculture Soil Science Department and Soil and Plant Analysis Laboratory at the Research and Development Centre of the Farmers' Union of Sales Cooperative at Ege University.

Soil samples were taken from each subplot at 0-15 cm depth for soil respiration analyses. The sampling was done prior to the sowing of soil building crops and after a period of decomposition of the previous main crop, tomato (September 27, 2007), after the incorporation of soil building crops (May 22, 2008) and after the incorporation of the zucchini plants (August 22, 2008).

4.2. Plant Performance

Presence of any physiological disorders on the plants was monitored by observations. For analyses, healthy and representative five broccoli plants, ten faba bean plants and three zucchini plants were selected from the experimental subplots. In vetch and fallow plots (natural vegetation) sampling was done by throwing the square frames (25x25cm) randomly and taking the plants inside the square as sample without breaking the integrity of the plants (including roots). Five samplings were done from fallow subplots and three samplings from vetch subplots. In broccoli and vetch plots, sampling was done before the plants were chopped (to prepare for incorporation). As faba bean and zucchini were not cut before incorporation, sampling was done just before incorporation of these plants. For biodiversity assessment, natural vegetation was sampled in fallow plots on March 25, 2008 and on July 24, 2008.

4.3. Quality

Five broccoli head samples were taken on December 12, 2008 from each subplot for determination of quality parameters namely physical properties and dry matter content.

For each zucchini subplot, five representative fruit samples were taken on July 02-09-16, 2008 for assessment of quality.

4.4. Shelf life

On July 23, 2008, zucchini samples were taken for shelf life analysis. Special care was given to the samples which were taken for shelf life analysis. Six representative fruits were chosen from all subplots and then these fruits were covered with paper to reduce the risk of any bruises and scratches that may later interfere and shorten the shelf life.

4.5. Phytosanitary status

During the growth period, observations were made in order to determine the incidence of pests and diseases. Monitoring was carried out every week from transplantation to the end of harvest time. The interval of monitoring was reduced in periods of maximum disease pressure or of plant susceptibility.

4.6. Spontaneous vegetation biodiversity

Two samplings were done, one on March 25, 2008 and the other on July 24, 2008.

Square frames having sides of 25 cm were thrown on the plots to identify randomized sub-sampling areas.

Frames were thrown 5 times for each plot (corresponding to a total sampled surface of 1.2 m^2 for each treatment) to have 1% of sampled surface in respect to the whole thesis area. Each time, the square frame is thrown it is pushed downward and laid on the soil. All plants within the frame have been counted according to species and taken in bags with a way able to preserve plant integrity (not simply cut). All species number data has been recorded in excel sheets.

5. Methods

5.1. Soil Analysis

Before analyzing each sample, soil was spread on trays and air-dried, then thoroughly mixed and rolled in a mortar to break up clods, and finally screened through a 2 mm sieve mesh.

5.1.1. Soil texture

The mechanical analysis for particles size has been carried out by the hydrometer method using sodium hexametaphosphate as a dispersing agent according to method described by Champman and Pratt (1961) and the soil texture has been determined based on the ratio of soil particles.

5.1.2. Soil pH

Soil pH has been determined in 1:2.5 soil water (weight/volume) suspensions, using a glass electrode pH – meter (Rhoades, 1982).

5.1.3. Soil organic matter and carbon content

Soil organic matter content was analyzed by means of the Walkley and Black method (Jackson, 1967).

Carbon content is calculated by applying the following formula:

Carbon (%)=Organic matter (%)/1.724

5.1.4. Major elements

Available N has been determined by shaking 10 g of soil with 100 ml of K_2SO_4 for one hour. An aliquot of 50 ml of the filtered extract has been subjected to steam distillation with MgO and Devarda alloy to determine N according to the procedure described by Keeny and Nelson (1982).

Available phosphorus has been determined by shaking 5 g of soil with 100 ml of $NaHCO_3$ 0.5 M for 1 hour; pH has been adjusted to 8.5. Phosphorus has been determined in 10 ml of the filtered extract colorimetrically by spectrophotometer using the stannous chloride method described by Jackson (1958).

Sodium and potassium has been determined using flame photometer according to Black *et al.* (1982).

Calcium and magnesium has been estimated by titration with versenate method, using ammonium purporate as an indicator for calcium and eriochrome black T. as an indicator for calcium and magnesium according to U.S.S.L. (1954).

5.1.5. Soil respiration

Soil respiration has been determined by a portable photosynthesis system (CI-301 PS CID, Inc.) using a soil chamber. Soil respiration (below ground) is defined as the total carbon dioxide efflux at the soil surface and known to be a combination of biotic (rhizosphere respiration, microbial respiration, faunal respiration), chemical (oxidation of soil minerals) and physical (soil degassing and transport of carbon dioxide to the surface) processes.

5.2. Plant Analyses

Plant samples for faba bean, broccoli and zucchini were separated into different parts as leaves, stems and roots and weighted separately. Plant samples for vetch and fallow plots are weighted without separating into plant parts instead total weight was taken for these samples.

Fresh and dry biomasses are determined for each pre-crop including weeds and zucchini. Calculations are made ($kg.ha^{-1}$) on the basis of plant density.

Plant samples were separated into different parts as leaves, stems, roots and fruits. Samples were cut into small pieces, spread out in single layers and dried at 65°C for 5 days (Nyabundi and Hsaio, 1989), and then the weight of oven dried samples was recorded to assess the dry matter weight. Dry matter content is calculated as follows:

DM = (Dry weight / Fresh weight) *100

Moisture content (%) is calculated by subtracting DM from 100.

5.2.1. Yield

For faba bean, as the production was terminated before full yield was achieved, data was not assessed.

For broccoli, each harvest was recorded as yield as both weight and number of fruits for main heads and side shoots.

For zucchini, fruit were harvested three times a week. Each harvest was recorded, as yield, weight and number of fruits for each subplot, and the total production per plant.

5.2.2. Quality

Weight (g), length (mm), diameter (mm) and bract number of the main head were measured for harvested broccoli. Five samples were taken and measured from each subplot.

For zucchini, the amount of fruit in marketable and non-marketable quality classes was determined both as number and weight. Weight (g), width (mm) and length (mm) of zucchini fruit was measured with a digital compass at three locations on the fruit as the middle, and 2cm inside each end. Average of these three measurements was taken as the average value for width. Measurements were done on five fruit samples from each subplot. All measurements were made on freshly harvested fruit.

Fruit firmness was measured as kg on zucchini fruits by an Effegi pressure tester using an oval type tip of 4 mm in diameter. It measures the pressure necessary to force a plunger of specified size in the pulp of the fruit. A suitable sample composed of 3 fruits was prepared and 2 measurements were made on each fruit at opposite sides at the middle part of the fruit. Average of these two measurements was taken as the average value for firmness

Ash content of zucchini fruits was calculated as follows; 2 g oven dried at 110˚C and grinded samples were burned at 550°C for 3 hours and weighted.

5.2.3. Shelf Life

Zucchini fruit samples were kept at 20±2˚C for 1 day and 2 days to analyze quality changes during for shelf life. Appearance was evaluated as structural and color deformation and firmness analyses were also carried out on these zucchini fruits.

5.3. Spontaneous vegetation's biodiversity assessment

All the collected data related to plant number and species for each subplot is represented as follows: Number of plants collected from each subplot, species number and percentage for each species are calculated for each of treatments separately (during pre-crop cycle and main crop cycle) and presented as a table.

5.4. Economic analysis

To complement the agronomic research work, economic evaluation associated to the different rotation programs and fertilization strategies have been evaluated. For this purpose the Gross Margin (GM) has been calculated for each of the eight tested treatments. Each calculated value represents the average of our data values collected from the four replications done for each treatment.

Difficulties related to the calculation of fixed costs under experimental conditions and in different countries led us to consider for our economic evaluation, the gross margin instead of the whole-farm budget calculation. It is noteworthy to mention that the gross margin is conventionally used for research in agricultural economy.

Data has been elaborated by calculating the average of variable costs (input, labor and machine costs) and gross income (output, yield) of each treatment according to the following equation:

GM= gross revenue (total gross income) – total variable costs (Kay and Edwards, 1999).

Data collection has been carried out throughout the experimental period and records have been taken for all the agronomic operations. For this purpose an apposite excel sheet was used for each treatment (see Annex 1)

Final results of the economic analysis are given in table 20.

5.5. Statistical analysis

Analysis of variance was done using the statistical analysis program SPSS V16.

Chapter 3

Results and discussion

1. Climatic conditions

The climatic conditions prevailing at the experimental site display a typical Mediterranean climate with warm and rainy winter and hot and dry summer. As could be seen in figure 7, the growth cycle of the pre-crops coincided with the rainy period; however, due to the late start of the first rainfall in October 2007, broccoli seedlings were irrigated once. In general, the site received higher rainfall in 2008 compared to 2007.

Figure 7 shows maximum, minimum and average temperatures and the relative humidity during the pre-crop and the main crop cycles.

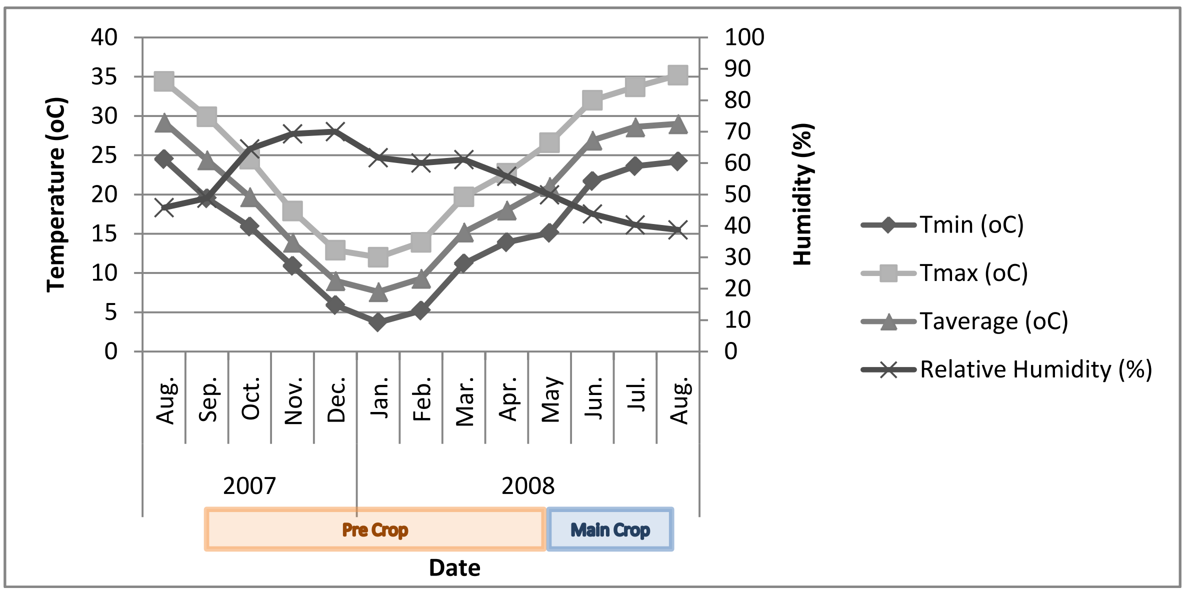

Figure 7. Monthly average climatic data during the experiment.

In the pre-crop cycle temperature decreased constantly from September ($T_{average}$= 24˚C) to January ($T_{average}$=8˚C), and afterwards temperature increased constantly to an average of 12°C in the beginning of May. During the pre-crop cycle maximum temperature reached 27°C in September and May and a minimum of 3.7°C during early January.

During broccoli production cycle average temperatures were 24.4˚C in September 19.7˚C in October and 13.9˚C in November which are very favorable for broccoli as it prefers average temperatures ranging from 15 to 24°C for best growth (Smith, 2003). For the legumes, winter temperatures were rather low during the whole cycle, - even the max temperatures - reaching 20°C only at the end of March while the optimum temperature needed for successful legume growth is reported to range between 20–22°C (Covell *et al.*, 1986).

There was a constant increase in both maximum and minimum temperatures during the main crop cycle starting in the spring and extended through summer. Average temperatures fluctuated between 27 and 29 °C. Maximum temperatures were higher than 30°C during most of the zucchini production cycle while minimum temperature was above 20°C. Such high temperature conditions are reported to be not too favorable for zucchini crop which is a warm-season crop and its optimal growth temperature range from 18°C to 24°C (Molinar *et al.*, 2000) due to its adverse effect on pollination.

Humidity levels increased till the middle of December and later on it constantly decreased until the end of the experiment.

Precipitations received during the pre-crop growth cycle (September 15, 2007 – May 6, 2008) amounted to 501.2 mm, was similar to the amount of the previous year (504.7 mm) but the distribution of the precipitations was so different. In September generally there was no rain; however, in 2007 a heavy rainfall (167.2 mm) occurred in that month. During October, November and December precipitations were high and distributed equally throughout the period which consequently delayed the sowing of vetch and faba bean.

In 2008, in March and April precipitation was higher than the previous year; however, May was rather dry. A total of 5.3 mm rainfall was recorded in May (Figure 8).

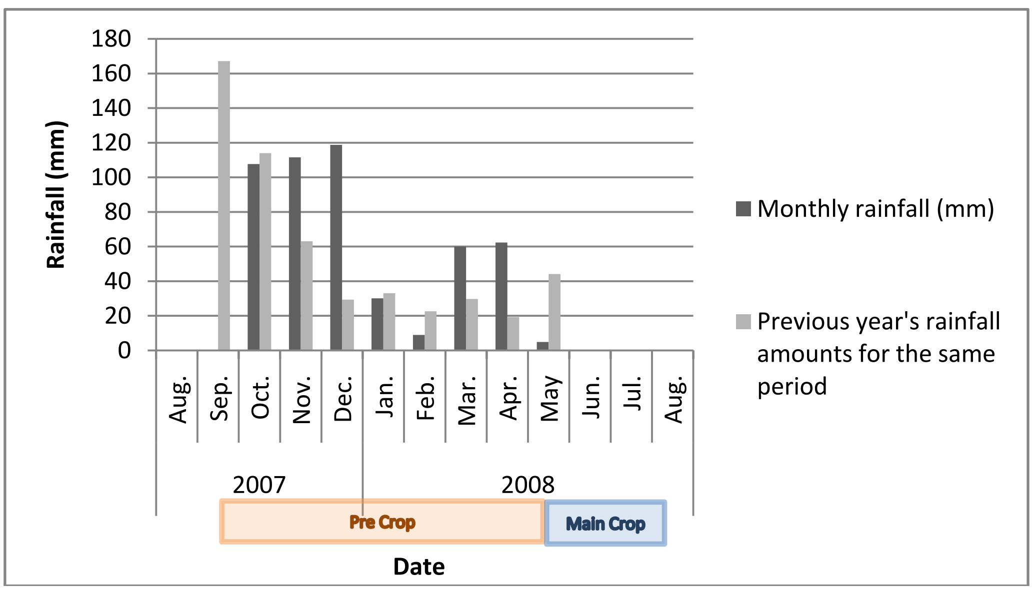

Figure 8. Monthly average rainfall during the experiment (mm).

2. Soil properties

2.1. Nutritional status

Figure 9 displays the evolution of the overall average of soil P and K contents of the experimental site. Results revealed a decline in soil P content after the pre-crops in the first cycle (2006-2007) and a slight increase after tomato, the first main crop. In respect to soil K, an increase after the first pre-crop was followed by a steady decrease.

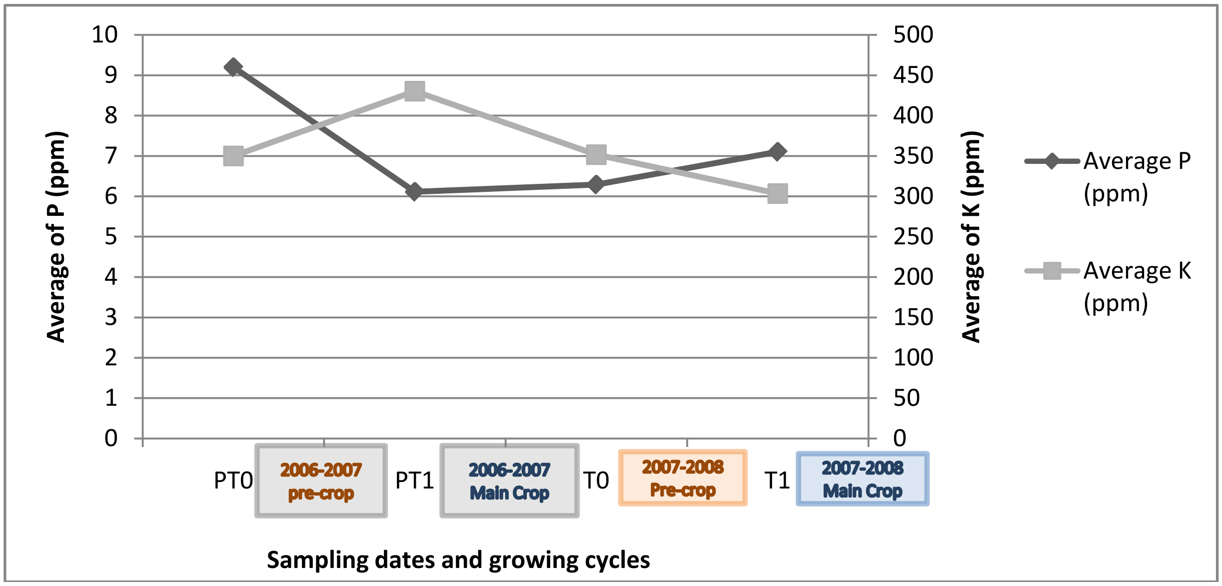

Figure 9. Changes in average soil P and K content (ppm) 2006-2007 and 2007-2008 experiments

The tested pre-crops grown during winter period of 2007-2008 had significant effects on soil composition (Table 9). The N content was the highest in the fallow plot and the lowest after faba bean. On the other hand, in respect to P, faba bean had the highest levels which could be also attributed to the fact that grain legumes increase the potassium availability (Erik, 2004). Fallow plots had statistically the same amount of P exceeding those of vetch and broccoli. The soil K decreased in plots in the order of fallow, faba bean, vetch and broccoli. In the experimental field, fertilizer treatments and the main crop in the first year (2006-2007) did not have any marked effects on soil N, P, K, organic matter levels or on C/N ratio.

Vetch as a soil building crop enhanced soil organic matter and thus organic carbon content, significantly. Faba bean and broccoli had the same effect as fallow and in statistical evaluation ranked together in the second group (Table 9). Fertilizer treatment or pre-crop*fertilizer interaction did not show significant effects. Tested variables did not have significant effect on soil C/N ratio.

Table 9. Statistical analysis of macro nutrient content, organic matter and carbon content and C/N ratio of the soil sampled on T1 (April 22, 2008) for different treatments.

Pre-crops(P)	Fertilization program (F)	N (%)	P (ppm)	K (ppm)	Organic Matter (%)	Carbon (%)	C /N ratio
Fallow	**CT**	0.115	7.79	372.19	1.938	1.124	9.951
	CF	0.117	7.77	397.19	2.034	1.180	10.580
Mean		0.016 a	7.78 a	384.69 a	1.986 b	1.152 b	10.268
Faba Bean	**CT**	0.112	7.83	374.63	2.001	1.161	10.448
	CF	0.109	7.76	370.88	2.267	1.314	11.924
Mean		0.110 b	7.79 a	372.75 a	2.134 b	1.238 b	11.186
Vetch	**CT**	0.112	6.55	354.63	2.513	1.429	12.269
	CF	0.112	6.58	359.63	2.314	1.342	10.546
Mean		0.112 ab	6.57 b	357.13 ab	2.414 a	1.385 a	11.407
Broccoli	**CT**	0.107	6.55	308.19	2.017	1.170	10.039
	CF	0.114	6.58	333.19	2.138	1.240	10.837
Mean		0.111 ab	6.57 b	320.19 b	2.077 b	1.205 b	10.438
Mean CT		0.112	7.27	352.41	2.117	1.221	10.677
Mean CF		0.113	7.09	365.22	2.188	1.269	10.972
LSD F		NS	NS	NS	NS	NS	NS
LSD P		0.005*	1.024*	51.937*	0.256**	0.147*	NS
LSD PxF		NS	NS	NS	NS	NS	NS

*NB: NS indicates non significance, * and ** indicate significance at 5% and 1% respectively.*

As could be seen in figure 10, average N level has a slight and stable increase during the first and second cycles of the rotation program. However, organic matter was enhanced in the soil after tomato or prior to the second year (2007-2008) pre-crops but after that it decreased.

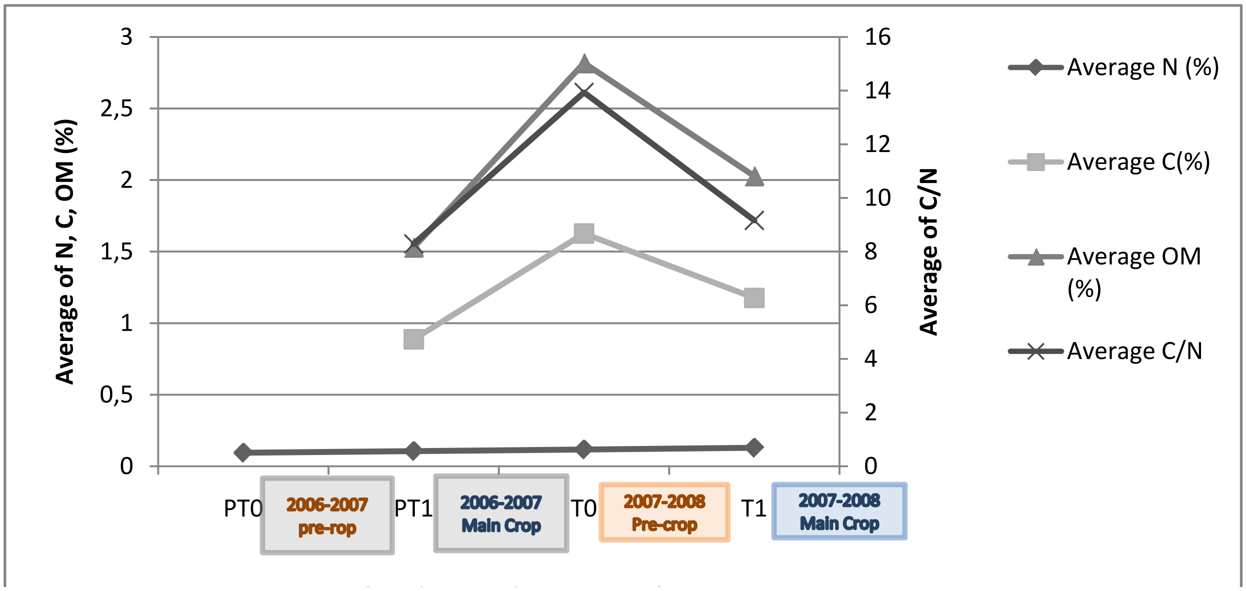

Figure 10. Average N, C, OM percentages and C/N ratio during 2006-2007 and 2007-2008 experiments.

It is important to mention that the obtained results related to the effects of pre-crops on soil nutrients cannot be generalized for every condition. As these results were created under specific yearly climatic conditions in which the soil was washed with rain water in vetch and faba bean subplots that were left without a cover during December. Soil was cultivated on December 7, 2007 to sow vetch and faba bean but it was not possible to sow until December 26, 2007 due to the high precipitation. This heavy rain was seen as the real reason to have smaller amounts of N from legume crops in which normally relatively higher N amounts are expected compared to other green manure crops. Between faba bean and vetch, faba bean was the lowest N contributor as vetch covered the soil faster than faba bean and besides some pods were harvested and removed from faba bean instead of incorporating totally. So this can be a good example for effects of leaching and shows a positive effect of spontaneous vegetation on soil. Owen *et al*. (2008) also state that soil nutrient supply was more affected by year than any other tested factor.

2.2. Soil respiration

Soil respiration rates measured in May 2008 after the pre-crop cycle were higher compared to the values obtained after the main crops in September 2007 (first year) or August 2008 (second year). The effect of different variables seemed to be more pronounced in May, as well. As could be seen in figure 11, soil N and organic matter contents were also higher in May compared to August 2008. The respiration rate was more stable in fallow-zucchini subplot fertilized with commercial fertilizer. Soil respiration rate was enhanced after May 2008 (after pre-crops) compared to August 2008 (after zucchini) in all subplots fertilized with commercial fertilizer, where it decreased in plots treated with compost tea. The addition of compost tea is known to enrich soil microbiota population which may have triggered the decomposition of organic matter incorporated at the end of the pre-crop cycle resulting in lower respiration levels in August. Mayer et al (2008) measured soil respiration in control and effective microorganisms (EM) applied plots and found that the effects of sampling time (spring and autumn) was more pronounced compared to the effect of treatments.

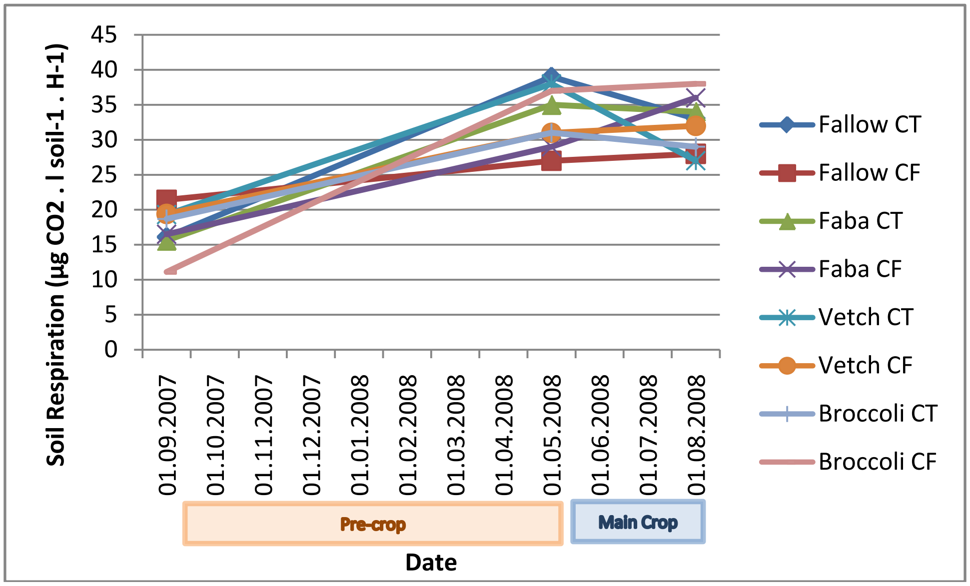

Figure 11. Soil respiration (µg CO_2 . l soil^{-1} . H^{-1})

3. Biodiversity of spontaneous vegetation

3.1. Biodiversity of spontaneous vegetation during the pre-crop growth cycle

There were a total of 34 to 812 plants and 4 to 8 species in each subplot. The highest number of spontaneous plant occurred in vetch and fallow subplots followed by faba bean, and the lowest numbers were in broccoli subplots. For species number, the highest diversity was seen in fallow and faba bean with 8 species in each fertilization treatment. Vetch and Broccoli subplots have a lower number of diversity of spontaneous vegetation varying from 4 to 7 species according to the subplot (Table 10). The most important species for fallow, vetch and faba bean subplots was *Capsella bursa-pastoris* with 46 to 76 percent. But for the Broccoli subplots' main species was *Avena fatua* with 52 to 62 percent. Table 10 and figure 12 show significant effects of pre crops on spontaneous vegetation but it is important to mention that these effects were also related to different cultural practices (like weeding) done to different subplots. Even the effects of pre-crops cannot be evaluated separately from cultural practices. Broccoli showed a significant effect on spontaneous vegetation, which is similar to the findings of Rizvi *et. al.* (1999).

Table 10. Biodiversity of spontaneous vegetation during the pre-cop growth cycle.

	Fallow				Faba Bean				Vetch				Broccoli			
	CT		C[a]		CT		C[a]		CT		C[a]		CT		C[a]	
Total number of plants	805		623		478		416		656		812		34		60	
Number of spesies	8		8		8		8		5		7		4		5	
Main Species	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%
	Capsella bursa-pastoris	71	*Capsella bursa-pastoris*	76	*Capsella bursa-pastoris*	49	*Capsella bursa-pastoris*	59	*Capsella bursa-pastoris*	46	*Capsella bursa-pastoris*	55	*Avena fatua*	62	*Avena fatua*	52
	Cichorium spp.	18	*Sorghum halepense* L. Pers.	17	*Taraxacum officinalis*	19	*Taraxacum officinalis*	20	*Cichorium* spp.	23	*Fumaria vaillanti*	28	*Raphanus raphanistrum* L.	18	*Raphanus raphanistrum* L.	40
	Sorghum halepense L. *Pers.*	7.5	*Avena fatua*	2,4	*Fumaria vaillanti*	13	*Fumaria vaillanti*	9.9	*Sorghum halepense* L. Pers.	16	*Sorghum halepense* L. *Pers.*	12	*Sorghum halepense* L. Pers.	12	*Capsella bursa-pastoris*	3,3
	Fumaria vaillanti	1.6	*Cichorium* spp.	2,1	*Agropyron-Elymus repens*	8.4	*Agropyron-Elymus repens*	6.7	*Fumaria vaillanti*	14	*Agropyron-Elymus repens*	3,4	*Capsella bursa-pastoris*	8.8	*Sorghum halepense* L. Pers.	3.3
	Agropyron-Elymus repens	0.7	*Fumaria vaillanti*	1,3	*Equisetum arvense*	5.9	*Equisetum arvense*	2.9	*Avena fatua*	1.6	*Raphanus raphanistrum* L.	0,6			*Cichorium* spp.	1.7
	Avena fatua	0.6	*Agropyron-Elymus repens*	1	*Urtica urens* L.	3.8	*Urtica urens* L.	1			*Urtica urens* L.	0.5				
	Raphanus raphanistrum L.	0.5	*Raphanus raphanistrum* L.	0.8	*Raphanus raphanistrum* L.	0.8	*Cichorium* spp.	0.7			*Cichorium* spp.	0.4				
	Urtica urens L.	0.1	*Urtica urens* L.	0.2	*Cichorium* spp.	0.2	*Raphanus raphanistrum* L.	0.2								

[a] .CF subplots are fertilized only with compost for previous year's (2006-2007) experiment and compost + commercial fertilizer for this year's experiment. But as there was no fertilization application during the pre-crop cycle they are named as C subplots.

Table 11. Biodiversity of spontaneous vegetation during the main crop growth cycle.

	Fallow				Faba Bean				Vetch				Broccoli			
	CT		CF		CT		CF		CT		CF		CT		CF	
Total number of plants	111		122		105		117		132		89		83		73	
Number of spesies	10		12		9		13		11		15		11		13	
Main Species	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%	Species Name	%
	Convolvulus arvensis L.	35.1	*Cyperus rotundus* L.	45.1	*Sorghum halepense L.* Pers.	27.6	*Cyperus rotundus* L.	28.2	*Cyperus rotundus* L.	51.5	*Cyperus rotundus* L.	34.8	*Cyperus rotundus* L.	24.1	*Cyperus rotundus* L.	31.5
	Cyperus rotundus L.	20.7	*Sorghum halepense* L. Pers.	16.4	*Convolvulus arvensis* L.	21.9	*Convolvulus arvensis* L.	20.5	*Elymus repens* L.	10.6	*Sorghum halepense* L. Pers.	30.3	*Convolvulus arvensis* L.	22.9	*Sorghum halepense* L.*Pers.*	31.5
	Portulaca oleracea L.	13.5	*Portulaca oleracea* L.	10.7	*Cyperus rotundus* L.	20.0	*Portulaca oleracea* L.	15.4	*Sorghum halepense* L. Pers.	9.8	*Portulaca oleracea* L.	20.2	*Sorghum halepense* L. *Pers.*	18.1	*Convolvulus arvensis* L.	19.2
	Sorghum halepense L. Pers.	12.6	*Convolvulus arvensis* L.	9.8	*Portulaca oleracea* L.	6.7	*Sorghum halepense* L.Pers.	12.8	*Portulaca oleracea* L.	9.1	*Convolvulus arvensis* L.	16.9	*Portulaca oleracea* L.	10.8	*Elymus repens* L.	16.4
	Tribulus terrestris	7.2	*Echinochloa crus-galli* L.	8.2	*Elymus repens* L.	5.7	*Elymus repens* L.	6.8	*Convolvulus arvensis* L.	6.8	*Tribulus terrestris*	11.2	*Solanum nigrum* L.	7.2	*Tribulus terrestris*	11.0
	Elymus repens L.	5.4	*Tribulus terrestris*	6.6	*Tribulus terrestris*	5.7	*Echinochloa crus-galli* L.	4.3	*Solanum nigrum* L.	3.8	*Solanum nigrum* L.	6.7	*Tribulus terrestris*	4.8	*Portulaca oleracea* L.	9.6
	Solanum nigrum L.	2.7	*Chenopodium* spp.	2.5	*Chenopodium* spp.	2.9	*Tribulus terrestris*	4.3	*Turgenia latifolia*	3.8	*Chenopodium* spp.	4.5	*Chenopodium* spp.	3.6	*Solanum nigrum* L.	8.2
	Others	2.7	Others	4.1	Others	3.8	Others	7.7	Others	4.5	Others	15.7	Others	8.4	Others	20.5

3.2. Biodiversity of spontaneous vegetation during the main crop growth cycle

The results were similar to the pre-crop cycle. There were a total of 73 to 132 plants and 9 to 15 species in each subplot. The highest number of spontaneous plant occurred in vetch and fallow subplots followed by faba bean and again the lowest numbers were from broccoli subplots. For species number, there was no clear difference for subplots but there was higher number of species in CF fertilized subplots (Table 11). The share of various species was closer to the pre-crop cycle. But the most important species for vetch and Broccoli subplots was *Cyperus rotundus L.* which is also the main species for CF fertilized fallow and faba bean subplots. The percentage of *Cyperus rotundus* L. occurring in subplots varied from 24.1 to 51. Main species in plots following fallow and faba bean and fertilized with CT were *Convolvulus arvensis* L. (35.1 %) and *Sorghum halepense* L. Pers. (27.6 %), respectively. Even if it was not significant, broccoli has the lowest number of plants also during the main crop production cycle which can only explained by the effect of allelopathic effects of broccoli.

4. Pre-Crop growth cycle

4.1. Biomass production

The fallow subplots following compost tea treated tomato (previous year's main crop (2006-2007)) production in the rotation had 6.6 % higher total biomass production per unit area compared to compost treated (Figure 12). The water to dry matter accumulation of the natural vegetation was similar in both compost tea and compost treated subplots.

The faba bean biomass produced per hectare in compost subplots (7825.06 kg) exceeded those of compost tea (7120.74 kg) plots. On the other hand natural vegetation was higher in compost tea yielding to almost equal total biomass production on fresh basis (Figure 12). The share of dry matter (23.9 %) in the composition of the faba bean in compost subplots was slightly lower than the compost tea subplots (25.1 %).

In vetch plots, the fresh biomass accumulated by the natural vegetation was more than the vetch (Figure 12) in both subplots. The fresh biomass composed of about 25% dry matter and 75 % water. Weed biomass was 7875.0 kg and 6862.5 kg per unit area in subplots following tomato (previous years (2006-2007) main crop) treated with compost tea and compost, respectively.

The fresh biomass in broccoli plots was 13385.11 kg and 15353.66 kg. ha^{-1} in compost tea and compost subplots, respectively. Weeds had an additional fresh biomass of 4412.5 kg and 4200.0 kg.ha^{-1} in compost tea and compost subplots (Figure 12).

4.1.1. Comparison of biomass produced in different plots by pre-crops and spontaneous vegetation

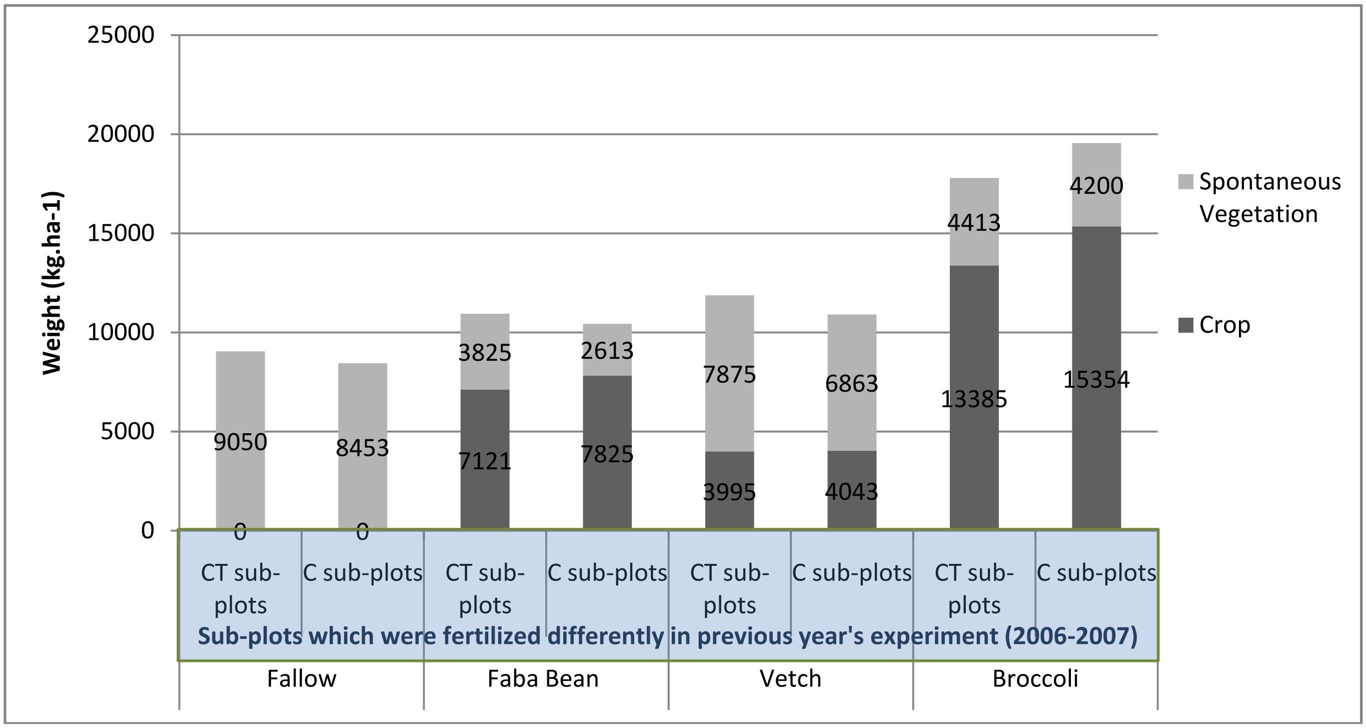

Figure 12. Biomass produced during pre-crop growth cycle (kg.ha^{-1}).

Statistical analysis show significant effects of pre-crops and fertilization on weed and crop biomass (Table 12). The crop biomass levels obtained from different pre-crops were different due to the different crops tested. For spontaneous vegetation, the effects of pre-crops were more related to cultural practices done to subplots than the effect of the pre-crop itself. In all the plots, spontaneous vegetation produced more biomass in compost tea fertilized (previous year's (2006-2007) fertilization) sub-plots than the compost fertilized sub-plots. For the crops (faba bean, vetch and broccoli), the situation was opposite: all the crops produced more biomass in compost fertilized (previous year's (2006-2007) fertilization) sub-plots compared to compost tea fertilized ones (Figure 12).

Spontaneous vegetation's biomass was the smallest for the faba bean plots but this was hardly related to the effect of the plant itself but mainly related to the operations done to the plots. On the other hand, broccoli plots possessing the second smallest spontaneous vegetation biomass was the most effective on spontaneous vegetation. Without any operations (weeding…) after the critical period for broccoli, it kept the spontaneous vegetation under pressure for nearly 6 months through the allelopathic substances that are produced by the roots of broccoli.

Table 12. Statistical analysis of spontaneous vegetation biomass during pre-crop cycle.

Pre-crops(P)	Previous years fertilization program (F)	Spontaneous vegetation for pre-crops
Fallow	**CT**	905.0
	C	845.3
Mean		875.1 a
Faba Bean	**CT**	382.5
	C	261.3
Mean		321.9 b
Vetch	**CT**	762.5
	C	686.3
Mean		724.4 a
Broccoli	**CT**	441.2
	C	420.0
Mean		430.6 b
Mean CT		622.8 a
Mean CF		553.2 b
LSD F		99.14**
LSD P		209.9**
LSD PxF		NS

4.2. Yield parameters for broccoli

4.2.1. Yield amount of broccoli

Broccoli harvest started in mid-December in 2007 and continued till March 2008. Starting in January, side shoots were also harvested (Figure 13). The total broccoli heads and side shoots harvested in both subplots were similar both in terms of weight and number (Figure 13).

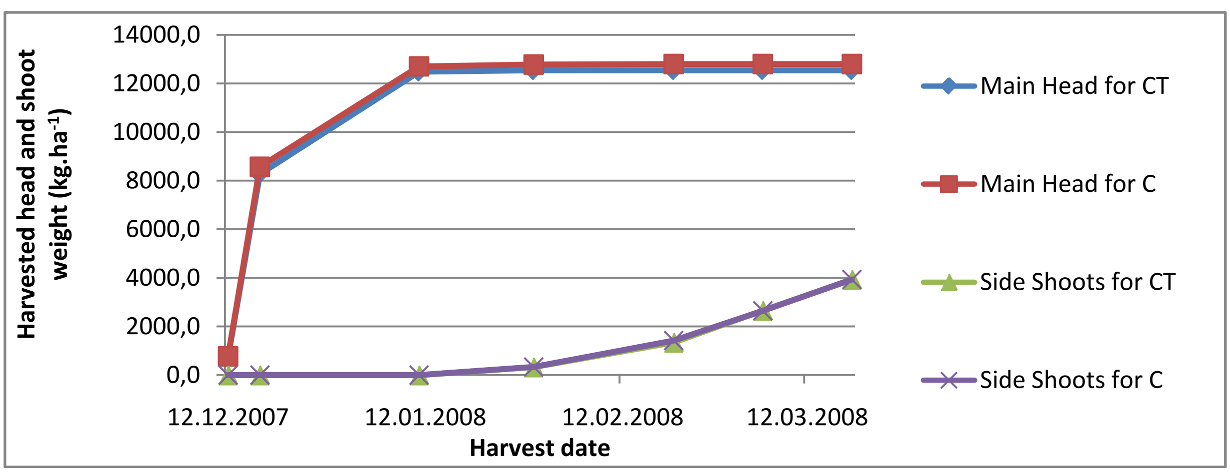

Figure 13. Cumulative broccoli main head and side shoot yield (kg.ha^{-1}).

4.2.2. Quality of broccoli

As could be seen in table 13, the size of broccoli heads were almost similar in subplots that received compost tea or compost alone during the tomato production(2006-2007). The average sizes were in conformity with the sizes stated in UN/ECE standard (Table 13), the diameter being in the middle of the range and height at the upper limit.

Table 13. Average quality parameters for a broccoli main head for subplots which are fertilized differently in previous years experiment and standard values.

Fertilization	Diameter (cm)	Height (cm)	Head weight (g)	Count of bract
CT	16.80	15.10	444.93	14.75
C	16.85	14.85	459.37	15.60
STANDARD	7.5 – 20	7.62-15.24		

5. Main crop growth cycle

5.1. Biomass Production

5.1.1. Zucchini biomass production

Subplots that received CT produced more total dry biomass per unit area during zucchini production compared to subplots where CF was applied. The differences between the two fertilizer treatments were more pronounced in plots that were occupied by faba bean or vetch during the pre-crop cycle (Figure 14).

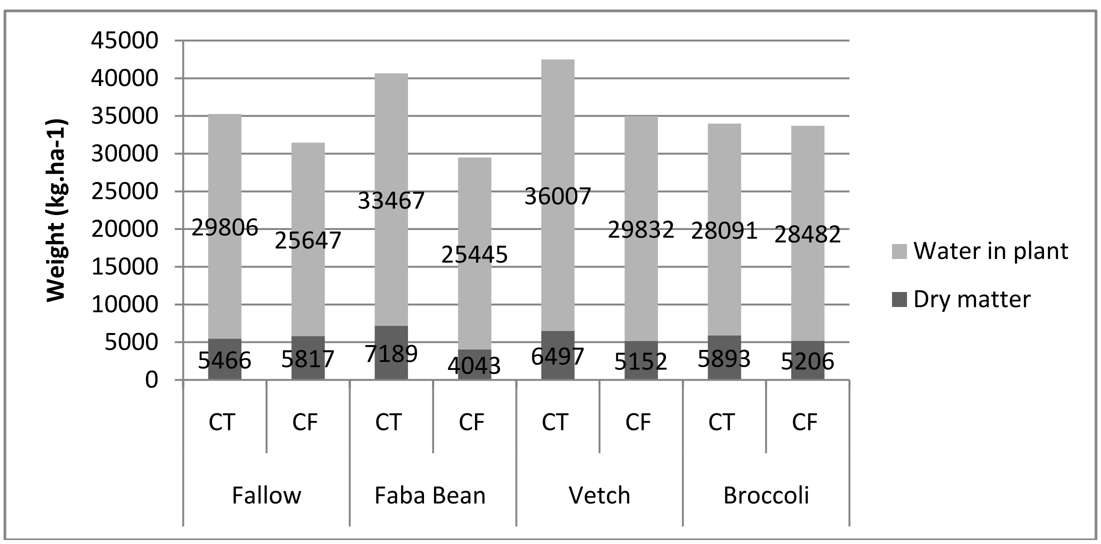

Figure 14. Biomass production of zucchini (kg.ha^{-1}).

Within the total zucchini plant, the aerial part represented 97.33% for CT and 97.36 % for CF subplots where as the root was 2.67% for CT and 2.64% for CF subplots. There were no marked effects of pre-crops or fertilization.

5.1.2. Comparison of biomass produced in different plots by main crop (zucchini) and spontaneous vegetation.

Subplots fertilized with CT gave higher zucchini fresh biomass compared to CF ones. Highest biomass was produced in plots occupied by vetch as pre-crop and fertilized with CT as 42504 $kg.ha^{-1}$ for zucchini and as 2916 $kg.ha^{-1}$ for spontaneous vegetation. The lowest was from faba bean fertilized with CF as a total of 31884 $kg.ha^{-1}$ (zucchini + spontaneous vegetation biomass). But all these differences were not statistically significant to show any marked effect of pre-crops or fertilization treatments on biomass production (Figure 15).

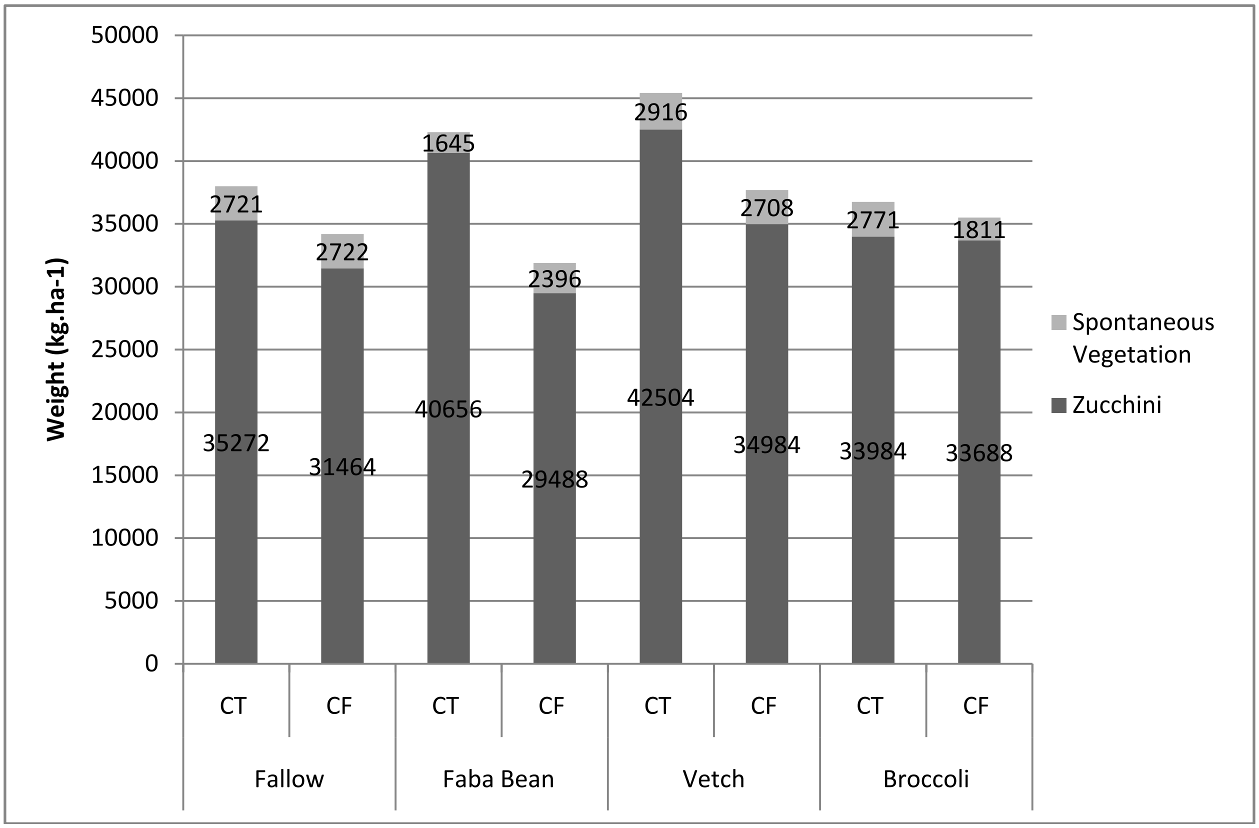

Figure 15. Total biomass produced by crop (zucchini) and weed during the main crop growth cycle (kg.ha-1).

5.2. Yield

5.2.1. Total yield

Number and weight of the yield for zucchini were taken for each harvest with one to two day intervals. Zucchini harvest started on June 21 and continued until August 4, 2008. The amount of fruit harvested showed a steady increase till June 21 and peaked at the end of July (Figure 16). The total amount of fruits harvested in a total of 20 harvests ranged between 21290.0 and 25463.3 kg.ha^{-1}. The effects of pre-crops, fertilizer treatments or their interaction were not statistically significant on zucchini total yield and number of fruits as it was found by Mohamed, (2007) (Table 14). Even if statistically not significant, vetch, fallow and faba bean subplots treated with the CF yielded in the first three positions (Figure 17).

Thomopoulos (2008) tested vetch (*Vicia sativa*) and faba bean (*Vicia faba*) as green manures in organic cotton production in clay loam soil (Athens, Greece) in 2005 and 2006 and no significant effect of green manuring on yield was obtained.

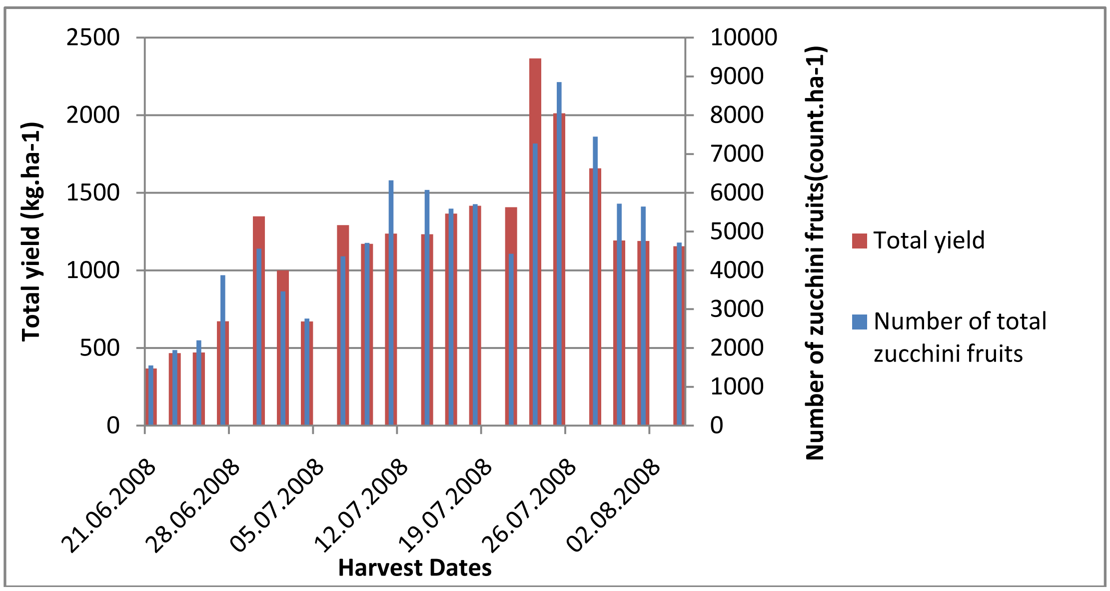

Figure 16. Total yield and number of total zucchini fruits for 20 harvest dates (kg.ha^{-1}).

Table 14. Statistical analysis for yield and number of fruits.

Pre-crops(P)	Fertilization program (F)	Yield (kg.ha^{-1})	Number of Fruits.ha^{-1}
Fallow	**CT**	21290.0	93333
	CF	25063.3	98667
Mean		23086.7	96000
Faba Bean	**CT**	22940.0	95667
	CF	24590.0	102250
Mean		23766.7	98960
Vetch	**CT**	23846.7	97000
	CF	25463.3	99083
Mean		24653.3	98043
Broccoli	**CT**	23613.3	97083
	CF	22760.0	94583
Mean		23186.7	95833
Mean CT		22923.3	95770
Mean CF		24470.0	98647
LSD F		NS	NS
LSD P		NS	NS
LSD PxF		NS	NS

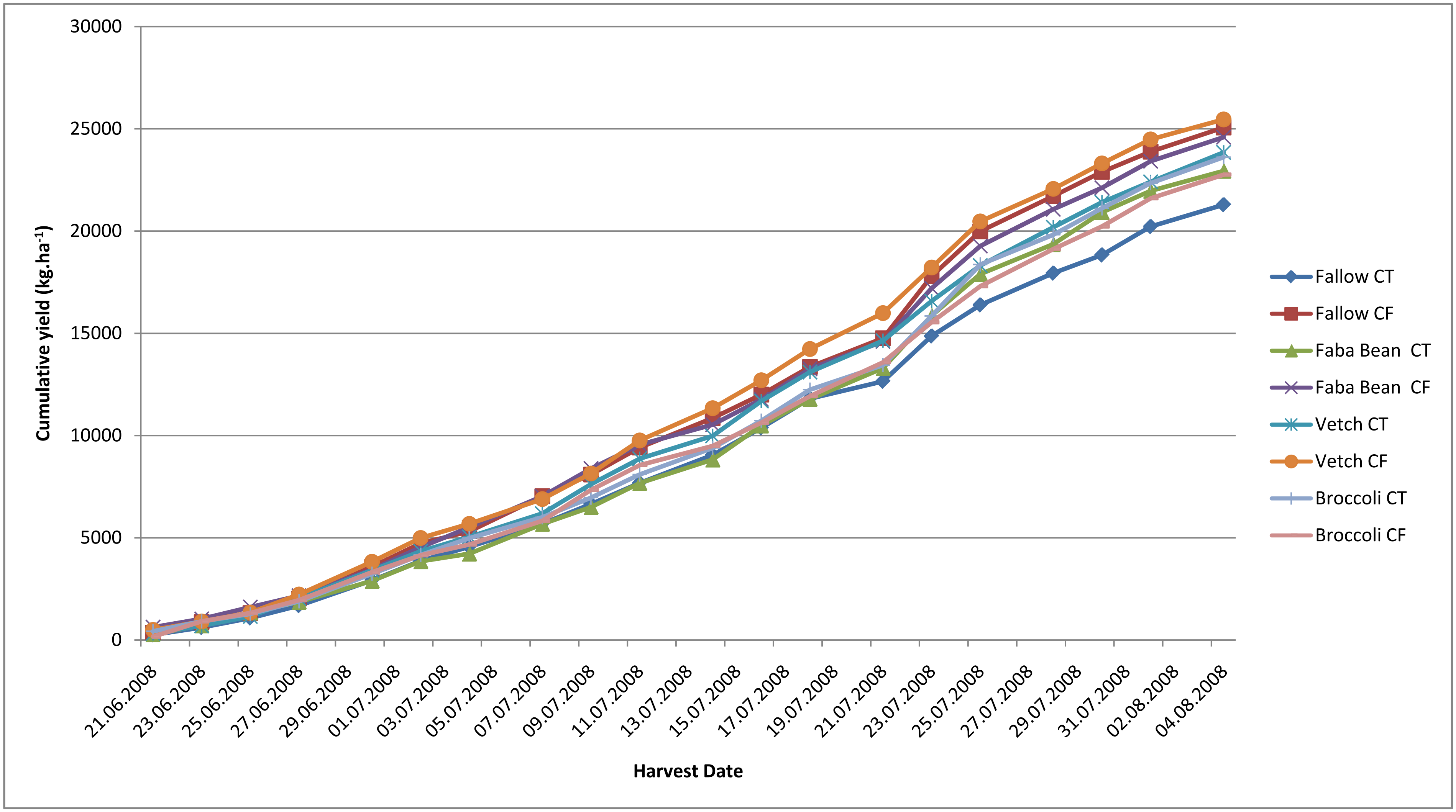

Figure 17. Cumulative zucchini yield on 20 harvest dates in different sub-plots (kg.ha-1).

Fruit yield per plant varied between 8.4 and 9.6 kg. CF gave higher number of fruit than compost tea (Figure 18). This difference was more marked in fallow-zucchini and the least in broccoli-zucchini rotation. In terms of the number of fruit per plant, CF subplots had higher numbers except subplot following broccoli.

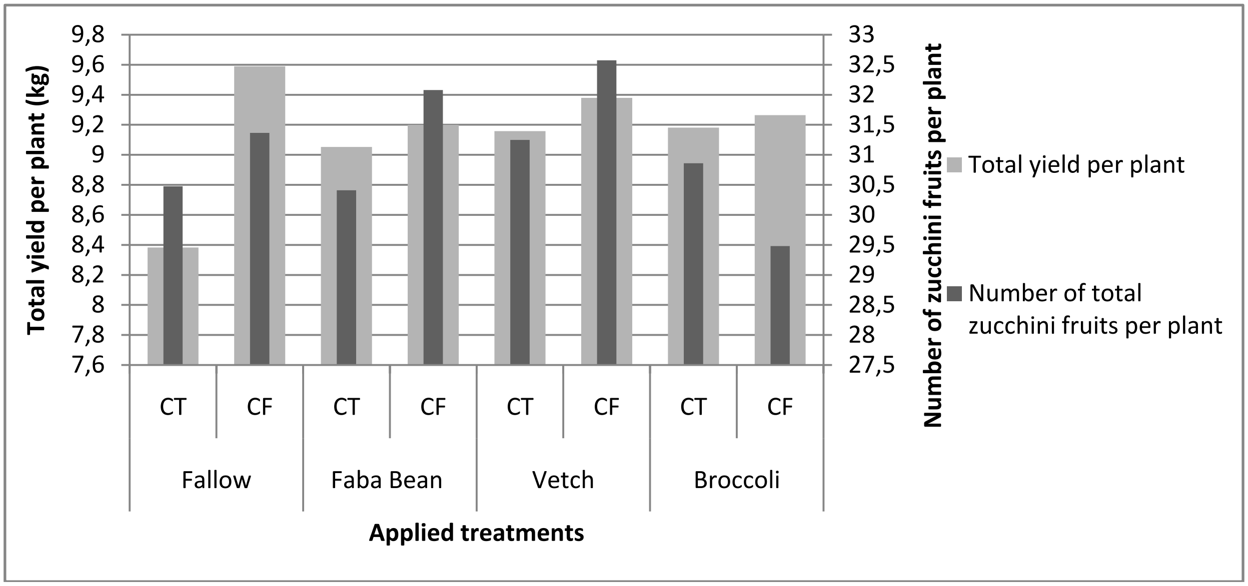

Figure 18. Total yield and number of zucchini fruits per plant for different treatments.

5.2.2. Marketable yield

Harvested fruits were screened for the defected fruits and the total amount of fruits that can be marketed was identified as ‘marketable yield’ (Figure 19). As could be seen in table 15, marketable yield ranged between 20953.3 and 25153.3 $kg.ha^{-1}$. When compared to total yield, high marketable fruit ratio signifies that most of the harvested fruit were classified as marketable and only few were found defected. The effects of tested variables, pre-crops and fertilizer treatment or their interaction on marketable yield were not significant.

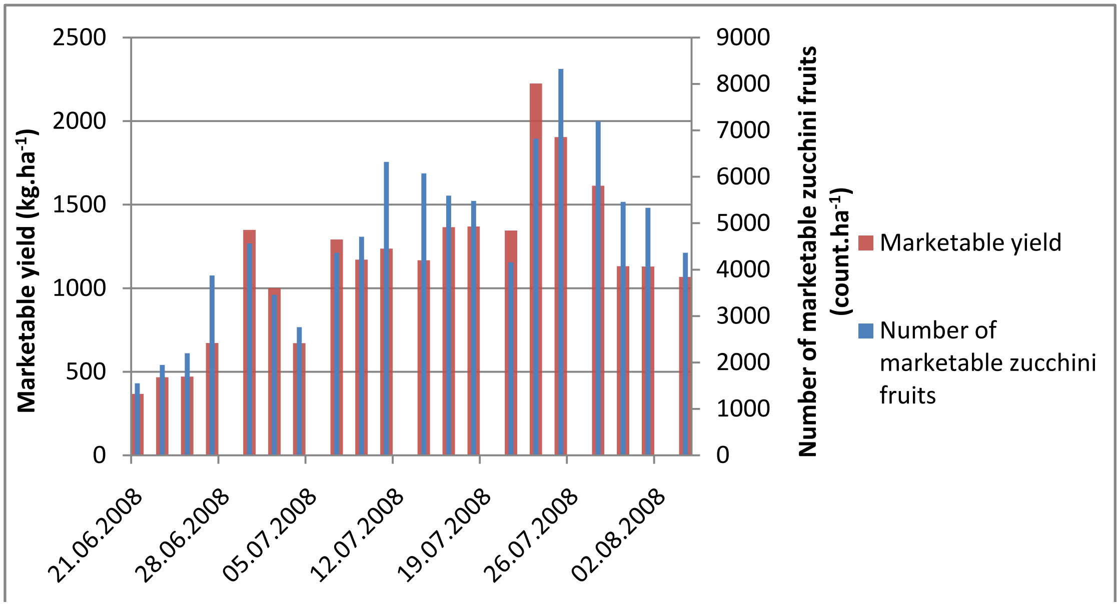

Figure 19. Marketable yield and number of total zucchini fruits for 20 harvest dates (kg.ha^{-1}).

Table 15. Statistical analysis for marketable yield and number of fruits.

Pre-crops(P)	Fertilization program (F)	Yield(kg.ha^{-1})	Number of Fruits count.ha^{-1}
Fallow	**CT**	20953.3	92000.0
	CF	24626.7	97500.0
Mean		22790.0	94750.0
Faba Bean	**CT**	22193.3	92083.3
	CF	24106.7	100416.7
Mean		23150.0	96250.0
Vetch	**CT**	22916.7	92750.0
	CF	25153.3	97250.0
Mean		24033.3	95000.0
Broccoli	**CT**	22640.0	94583.3
	CF	21553.3	89833.3
Mean		22096.7	92208.3
Mean CT		22176.7	92854.3
Mean CF		23860.0	96250.0
LSD F		NS	NS
LSD P		NS	NS
LSD PxF		NS	NS

5.3. Phytosanitary status

There were no serious pest or disease problems. White fly (*Bemisia argentifolii*) and red mite populations were observed but they never exceeded the threshold levels. Leaf hoppers (*Asymmetrasca decedens)* also seen in the experimental field which created a problem by transmitting CMV (Cucumber mosaic virus) but as this happened at the end of the production season no control measures were applied.

Percentage of CMV infected plants ranged between 12.27% and 18.49% (Table 16). The lowest was in fallow treated with compost tea whereas the highest was in fallow treated with commercial fertilizer. All the other subplots had percentage (about 15) varying between these two.

But these differences were not significant as percentage or after angular transformation (Snedecor and Cochran, 1967) of the results (Table 16).

Table 16. Statistical analysis of CMV as percentage and after angular transformation.

Pre-crops(P)	Fertilization program (F)	CMV (%)	CMV (%) after angular transformation
	CT	12.27	0.357
Fallow	CF	18.49	0.438
Mean		15.38	0.398
	CT	12.54	0.358
Faba Bean	CF	14.92	0.390
Mean		13.73	0.374
	CT	16.72	0.419
Vetch	CF	15.66	0.394
Mean		16.19	0.406
	CT	14.59	0.390
Broccoli	CF	15.05	0.393
Mean		14.82	0.392
Mean CT		14.03	0.381
Mean CF		16.03	0.404
LSD F		NS	NS
LSD P		NS	NS
LSD PxF		NS	NS

5.4. Quality

The average dimensions of the zucchini fruit were determined as 4.4 (w) x 16.7 cm. Average fruit weight was calculated as 222.85 g. The fruit quality determined as size, firmness and moisture content was not affected significantly by the fertilizer treatments or the pre-crops tested (Table 17).

Table 17. Fruit quality parameters determined in Zucchini fruits sampled on 09 July 2008.

Pre-crops(P)	Fertilization program (F)	Width (mm)	Length (cm)	Firmness (kg)	Average weight (g)	Dry matter (g)	Moisture (%)
Fallow	**CT**	41.72	16.67	3.4	207.36	5.45	94.55
	CF	43.89	17.28	3.27	232.10	5.03	94.97
Mean		42.80	16.97	3.33	219.73	5.24	94.76
Faba Bean	**CT**	40.86	16.43	3.44	208.00	5.79	94.22
	CF	42.83	17.05	3.41	233.50	5.51	94.49
Mean		41.84	16.74	3.43	220.75	5.65	94.35
Vetch	**CT**	44.30	17.00	3.29	226.20	4.31	95.69
	CF	43.06	16.84	3.21	211.53	4.44	95.56
Mean		43.68	16.92	3.25	218.86	4.37	95.63
Broccoli	**CT**	43.63	17.13	3.26	218.60	5.39	94.61
	CF	44.39	16.32	3.3	227.09	4.00	96.00
Mean		44.00	16.72	3.28	222.85	4.69	95.31
Mean CT		42.64	16.81	3.35	215.04	5.23	94.77
Mean CF		43.54	16.87	3.3	226.05	4.74	95.26
LSD F		NS	NS	NS	NS	NS	NS
LSD P		NS	NS	NS	NS	NS	NS
LSD PxF		NS	NS	NS	NS	NS	NS

Statistical analysis showed significant effects of fertilization treatments on ash content of zucchini fruits (Table 18). Organic matter contents were higher in commercial fertilizer treatments in all subplots. Compost tea treatments yielded significantly higher ash (inorganic matter) contents compared to commercial fertilizer showing higher uptake of inorganic nutrients accumulating in fruits. Ash contents decreased in the order of compost tea treated broccoli, vetch, fallow and faba bean and then commercial fertilizer treated vetch, faba bean, broccoli and fallow.

Table 18. Ash content (% dry matter) of zucchini fruits

Pre-crops(P)	Fertilization program (F)	Ash content (% dry matter)
Fallow	CT	20.00
	CF	14.55
Mean		17.30
Faba Bean	CT	19.15
	CF	17.15
Mean		18.15
Vetch	CT	20.05
	CF	18.35
Mean		19.45
Broccoli	CT	22.35
	CF	16.9
Mean		19.6
Mean CT		20.05a
Mean CF		16.75b
LSD F		0.026**
LSD P		NS
LSD PxF		NS

5.5. Shelf life

Harvested fruits require few days for handling and storage until they are consumed. In order to assess the changes in quality at post-harvest stage, zucchini fruit were kept at 20±2 for 1 and 2 days. Fruit firmness decreased in the second day in samples harvested from faba bean-zucchini subplots and CT fertilized zucchini plots following vetch and broccoli rotation. Zucchini fruit softened more in subplots that were occupied by faba bean and broccoli as pre-crops and treated with compost tea. For other subplots, firmness increased which is more related to the structural deformation due to moisture loss. In reality, fruits did not get harder but the texture of zucchini became like more elastic so the obtained firmness results were higher (Table 19).

Even though there were no significant differences between treatments in respect to structural deformation, compost tea treated zucchini subplots following vetch and broccoli had higher percentages (Figure 20 and Table 19).

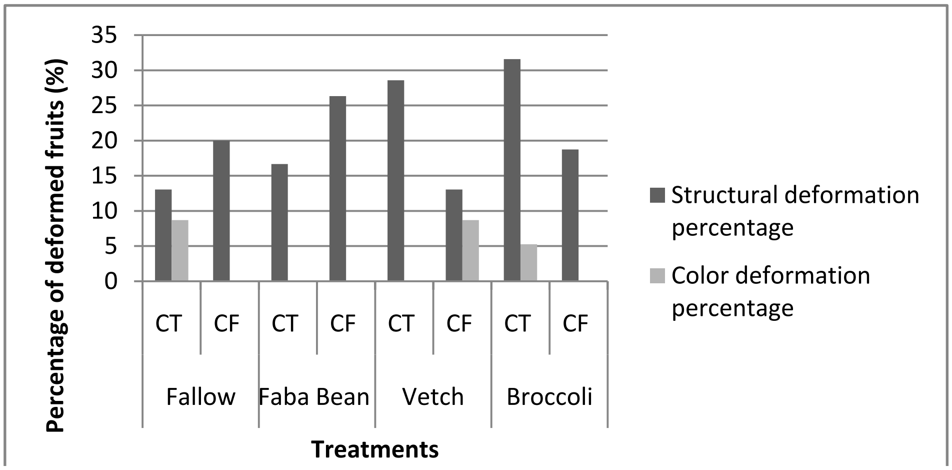

Figure 20. Percentage of deformed zucchini fruits stored under 20±2 ˚C for two days.

Table 19. Statistical analyses related to shelf life of the zucchini fruits.

Pre-crops(P)	Fertilization program (F)	1. firmness	2. firmness	Structural deformation (%)	Structural deformation after angular transformation
Fallow	**CT**	2.884	3.068 a	23.33	0.500
	CF	3.068	3.232	35.56	0.630
Mean		2.976	3.150	29.44	0.565
Faba Bean	**CT**	3.068	2.708 b	30.00	0.571
	CF	2.988	2.912	30.00	0.574
Mean		3.028	2.810	30.00	0.573
Vetch	**CT**	2.998	2.87 ab	25.00	0.520
	CF	2.954	3.112	47.77	0.762
Mean		2.976	2.992	36.38	0.641
Broccoli	**CT**	3.082	2.75 b	20.00	0.464
	CF	2.828	2.886	0.00	0.000
Mean		2.995	2.819	20.00	0.464
Mean CT		3.008	2.850 b	25.50	0.524
Mean CF		2.959	2.968 a	36.36	0.641
LSD F		NS	NS	NS	NS
LSD P		NS	0.228*	NS	NS
LSD PxF		NS	NS	NS	NS

6. Economic analysis

The highest *total variable costs* were registered in the broccoli-zucchini rotation fertilized with CF. This is primarily due to both the high broccoli's seedlings costs as well as the harvest labor costs.

All treatments with CF applications resulted in higher variable costs compared to those of the same rotation fertilized with compost tea resulting in lower corresponding gross margins. The higher costs of treatments with CF applications principally due to the high prices of CF compared to the CT ones.

The highest total revenues were registered in the treatments with CF except for broccoli-zucchini where this rotation with CT application registered higher revenue with respect to CF application. These differences in revenues are directly related to the respective yields of zucchini.

The highest *gross margin* was registered in the sub-plots with broccoli-zucchini rotation with CT application, recording an average of 232.60 €.100m^{-2} and followed by 192.87 €.100m^{-2}for the same rotation with CF application while the lowest gross margin resulted in the sub-plots with faba bean-zucchini rotation fertilized with CF (130.45 €.100m^{-2}). The gross margin showed to be higher for the sub-plots with CT treatments compare to CF (from 232.60 to 155.31 €.100m^{-2}).

Despite the gross margin values, the highest revenues for zucchini are registered in the rotation of vetch (254.63 €.100m^{-2}) followed by the fallow-zucchini one (250.63 €.100m^{-2}) both with CF application.

Table 20 shows the variable costs, revenues and gross margin of the production cycle.

Table 20. Economical analysis of eight different treatments (€.100m^{-2}).

	Pre-crop production cycle							
	Broccoli - Zucchini		**Vetch** - Zucchini		**Faba bean** - Zucchini		**Fallow** - Zucchini	
	CT	CF	CT	CF	CT	CF	CT	CF
Variable costs for pre-crop	**40.54 €**	**40.79 €**	**13.74 €**	**13.74 €**	**24.86 €**	**24.50 €**	**2.50 €**	**2.50 €**
Seedlings /plants	16.47 €	16.47 €	0.80 €	0.80 €	3.75 €	3.75 €	- €	- €
Fertilizers	- €	- €	- €	- €	- €	- €	- €	- €
Pesticides (authorized)	- €	- €	- €	- €	- €	- €	- €	- €
Water	0.04 €	0.04 €	- €	- €	- €	- €	- €	- €
Other input	- €	- €	- €	- €	- €	- €	- €	- €
Labor	21.83 €	22.07 €	4.17 €	4.17 €	14.83 €	14.48 €	- €	- €
Machine costs	2.21 €	2.21 €	8.77 €	8.77 €	6.27 €	6.27 €	2.50 €	2.50 €
Revenues for pre-crop	**97.19 €**	**98.75 €**	**- €**	**- €**	**5.75 €**	**3.99 €**	**- €**	**- €**
Gross Margin for pre-crop	**56.64 €**	**57.96 €**	**-13.74 €**	**-13.74 €**	**-19.11 €**	**-20.51 €**	**-2.50 €**	**-2.50 €**
	Main crop production cycle							
	Broccoli **- Zucchini**		Vetch **- Zucchini**		Faba bean **- Zucchini**		Fallow **- Zucchini**	
	CT	**CF**	**CT**	**CF**	**CT**	**CF**	**CT**	**CF**
Variable costs for main crop	**60.18 €**	**93.67 €**	**53.11 €**	**97.31 €**	**54.99 €**	**94.94 €**	**54.58 €**	**97.69 €**
Seedlings /plants	2.30 €	2.33 €	2.23 €	2.35 €	2.28 €	2.23 €	2.38 €	2.30 €
Fertilizers	8.46 €	49.50 €	8.46 €	49.50 €	8.46 €	49.50 €	8.46 €	49.50 €
Pesticides (authorized)	0.16 €	0.17 €	0.16 €	0.16 €	0.16 €	0.16 €	0.16 €	0.16 €
Water	2.17 €	2.17 €	2.17 €	2.17 €	2.17 €	2.17 €	2.17 €	2.17 €
Other input	- €	- €	- €	- €	- €	- €	- €	- €
Labor	39.26 €	31.67 €	32.27 €	35.30 €	34.09 €	33.05 €	33.58 €	35.72 €
Machine costs	7.84 €	7.84 €	7.84 €	7.84 €	7.84 €	7.84 €	7.84 €	7.84 €
Revenues for main crop	**236.14 €**	**227.58 €**	**238.48 €**	**254.63 €**	**229.40 €**	**245.90 €**	**212.88 €**	**250.63 €**
Gross Margin for main crop	**175.96 €**	**133.91 €**	**185.36 €**	**157.31 €**	**174.41 €**	**150.96 €**	**158.29 €**	**152.95 €**
	Total values (for "pre-crop" + "main crop" production cycles)							
	Broccoli - Zucchini		**Vetch - Zucchini**		**Faba bean - Zucchini**		**Fallow - Zucchini**	
	CT	**CF**	**CT**	**CF**	**CT**	**CF**	**CT**	**CF**
Total Variable Costs	**100.73 €**	**134.45 €**	**66.85 €**	**111.05 €**	**79.84 €**	**119.45 €**	**57.08 €**	**100.19 €**
Total Revenues	**333.33 €**	**326.33 €**	**23.848 €**	**254.63 €**	**235.15 €**	**249.89 €**	**212.88 €**	**250.63 €**
Total Gross Margin	**232.60 €**	**191.87 €**	**17.162 €**	**143.58 €**	**155.31 €**	**130.45 €**	**155.79 €**	**150.45 €**

Conclusions and recommendations

During the pre-crop cycle, biomass produced was the highest in broccoli plots and then in faba bean whereas vetch gave the lowest biomass. Broccoli showed higher performance in terms of produced fresh and dry biomass. The leguminous pre-crops were grown under competition of weeds for water and nutrients which was further reflected on their biomass production. In addition to spontaneous vegetation, broccoli still has the highest biomass production. Vetch became the second and faba bean became the third in terms of total biomass production. The lowest biomass was produced in fallow plots.

Agronomic practices applied to control pest, disease and weeds and soil fertility were effective to obtain plant growth, yield and quality comparable to the conventional systems. Yield amounts were fair compared to a low input conventional system but a high input system with a hybrid zucchini can produce 2 to 3 times higher yields. As the vegetable crops demand high level of nutrients, it would be unfair to compare the organic management system practiced in the experiment with a high input system and especially with the yield data obtained only for one year. In the long term, with increasing input demands and variable costs high input production systems will become less and less beneficial throughout the years for farmers where the organic production systems get more beneficial.

Soil physical and chemical analysis following the harvest of the pre-crops showed significant effects of pre-crops on soil nitrogen, phosphorus, potassium, organic matter and carbon contents which were closely related to the climatic conditions. These results were a good example for effects of leaching which should encourage farmers to use cover crops or spontaneous vegetation instead of leaving the soil without cover.

The effect of pre-crops and fertilization treatments were not significant on yield and fruit quality parameters of zucchini like diameter, firmness, average fruit weight and fruit dry matter. This result can be attributed to the fact that vegetables are generally high nutrient demanding crops especially in early growing stages. Even though there were significant differences for nutrient and organic matter contents between different sub-plots, these differences were not enough to create significant impact on yield amount and quality. But for the inorganic content of the fruits, fertilization applications had a significant effect in favor of compost tea application.

The economic analysis showed that the most profitable rotation was zucchini after broccoli in general and with CT application in particular. Since this rotation had two commercial crops, it gave two crop harvests and resulted in higher income. However, in the long term as both of these crops are consuming soil, rotations with cover crops are expected to become more profitable. The less profitable rotation was faba bean-zucchini fertilized with CF. Sub-plots which were fertilized with CF gave higher revenues besides broccoli plots but price to benefit ratio was not enough to make CF a profitable application for farmers. Also, the use of on-farm organically-produced inputs (compost, compost tea) should interest farmers more than using commercial fertilizers, which, availability remains dependent from the foreign market. As for the experiment, compost was also a commercial one to make easier the comparison of the effects through the years but to produce the compost on farm would be economically feasible and applicable for a willing farmer.

Finally, it is noteworthy to mention that all the above comments need to be confirmed in the forthcoming experiments to be able to draw more consolidated and well founded conclusions.

Based upon the obtained results and experiences gained, the following recommendations could be made:

The experimental plan was not able to give significant differences of treatments in respect to yield quantity and quality. Some revisions can be done to experiment plan (for example for fertilization plan) to improve diversification of the treatments

The calendar needs to be revisited, and the sowing or transplanting dates must be taken to an earlier date in order to allow adequate time span for harvesting pre-crops and to have adequate time between incorporation of soil building crops and the transplantation of the main crop. Although earlier dates were planned for sowing, the weather conditions (heavy rain) delayed the sowing of faba bean and vetch making climate one of the major factors determining production.

The amount of nutrients added through leguminous crops and incorporated biomass can be calculated prior to the main crop. Instead of applying the same amount of compost or compost tea, compost may be applied at a different level according to the soil organic matter and N contents. As for the P and K the nutrient levels were also low so the fertilization system should be reviewed to improve the levels, too.

References

Abdelhamid M.T., Horiuchi T. and Oba S. (2004). Composting of rice straw with oilseed rape cake and poultry manure and its effects on faba bean (*Vicia faba* L.) growth and soil properties. *Bioresource technology*, 93:183-189.

Adams P.B. (1990). The potential of mycoparasites for biological control of plant diseases. *Annual review of phytopathology*, 28: 59-77.

Altieri M.A. (1995). Agroecology: The Science of sustainable agriculture. Intermediate Technology Publications, London.

Andres T.C. (2004). Web site for the plant family Cucurbitaceae & home of the cucurbit Network. <http://www.cucurbit.org/family.html>.

Antler S. (2000). Testing compost for agricultural application. *Composting council of Canada*.

Ashraf M., Mahmood T., Azam F. and Qureshi R.M. (2004). Comparative effects of applying leguminous and non-leguminous green manures and inorganic N on biomass yield and nitrogen uptake in flooded rice (*Oryza sativa* L.). *Biology and fertility of soils*, 40:147-152.

Babadoost M. (2000). Outbreak of *phytophthora* foliar blight and fruit rot in processing pumpkin fields in Illinois. *Plant disease,* 84:1345.

Bailey K.L. and Lazarovits G. (2003). Suppressing soil-borne diseases with residue management and organic amendments. *Soil and tillage research,* 72:169-180.

Barnett V., Payne, R. and Steiner R. (Eds.), 1995. Agricultural sustainability. economic, environmental and statistical considerations. Wiley, New York, p. 266.

Barrios Masias F. and Jackson L., (2008). Effects of pre-crops on soil respiration. *16th IFOAM Organic World Congress, Cultivating the Future Based on Science*, Organic Crop Production, Vol 1, 656-659.

Becker M., Ladha J. K. and Ali M. (1995). Green manure technology: potential, usage and limitations. A case study for lowland rice. *Plant and soil,* 174(1-2): 181-194.

Bess V.H. (2000). Understanding compost tea. *Biocycle journal of composting and organic recycling*, 41: 71.

Date of the last access to the web sites: 30 September 2008

Black C.A., Evans D.D., Whiten J.I., Ensmingercand L.E. and Clarck F.E. (1982). Methods of Soil Analysis. Part 2. Chemical and microbiological properties, In: Page A.L. (ed) Agronomy Inc. Madison, Wisconsin USA.

Bohn H.L. (1982). Estimate of organic carbon in world soils. *Soil science society of America journal,* 40: 468–470

Bonjour E.L. and Fargo W.S. (1989). Host effects on the survival and development of *Anasa tristis* (Heteroptera: Coreidae). *Environmental entomology,* 18:1083-1085.

Boyhan G.E., Granberry D.M. and Terry Kelley W. (1999). Squash: Commercial vegetable production. University of Georgia. <http://pubs.caes.uga.edu/caespubs/pubs/PDF/C527.pdf>.

Brinton W., Storms P., Evans E. and Hill J. (2004). Compost teas microbial hygiene and quality in relation to method of preparation. *Biodynamics*. 197: 12-15.

Bugg R.L., Ellis R.T. and Carlson R.W. (1989). Ichneumonidae (Hymenoptera) using extrafloral nectar of faba bean (*Vicia faba* L., Fabaceae) in Massachusetts. *Biological agriculture and horticulture* 6: 107-114

Bugg R.L., McGourty G., Sarrantonio M., Lanini W. T. and Bartolucci R. (1996). Comparison of 32 cover crops in an organic vineyard on the north coast of California. *Biological agriculture and horticulture* 13:65-83

Burket J., Sandeno J., Hemphill D. and Dick R. (2003). Cover crop nitrogen for summer vegetable crops. Oregon state university. <http://extension.oregonstate.edu/catalog/pdf/em/em8803-e.pdf>.

Buttery B.R. and Gibson A.H. (1990). The effect of nitrate on the time course of nitrogen fixation and growth in *Pisum sativum* and *Vicia faba*. *Plant and soil* 127:143-146.

Capinera J.L. (2000). Melon aphid. University of Florida, Institute of Food and Agricultural Services, Department of Entomology and Nematology. <http://creatures.ifas.ufl.edu/veg/aphid/melon_aphid.HTM>.

Caporali F., Campiglia E., Mancinelli R. and Paolini R. (2004). Maize performances as influenced by winter cover crop green manuring. *Italian journal of agronomy*, 8(1): 37-45.

Carter M.R., Sanderson J.B. and MacLeod J.A. (2004). Influence of compost on the physical properties and organic matter fractions of a fine sandy loam throughout the cycle of a potato rotation. *Canadian journal of soil science,* 84: 211-218.

Chae D. H., Jin D. R., Hwangbo H., Kim Y. W., Kim Y.C., Park R. D., Krishnan H.B and Kim K.Y.(2006). Control of late blight *Phytophthora capsici* in pepper plant with a compost containing multitude of chitinase-producing bacteria. *Biocontrol*, 51(31): 339-351.

Cook R.J. and Baker K.F. (1983). The Nature and practice of biological control of plant pathogens. *The American society of phytopathology.,* p 539

Diver S., Kuepper G. and Born H. (1999). Organic tomato production. <http://attra.ncat.org/attra-pub/tomato.html>

Duke J. A. (1981). Handbook of legumes of world economic importance. Plenum Press, New York.

Edwards L., Burney J.R., Richter G. and MacRae A.H. (2000). Evaluation of compost and straw mulching on soil-loss characteristics in erosion plots of potatoes in Prince Edward Island, Canada. *Agriculture, ecosystems and environment*, 81: 217-222.

Eghball B. and Power J.F. (1999). Phosphorus and nitrogen-based manure and compost applications: Corn production and soil phosphorus. *Soil science society of America journal,* 63: 895-901.

Eriksen J. and Jensen L.S. (2001) Soil respiration, nitrogen mineralisation and uptake in barley following cultivation of grazed grasslands. *Biology and fertility of soils* 33: 139-145.

Eswaran H., van den Berg E. and Reich P. (1993). Organic carbon in soils of the world. Soil science society of America journal, 57: 192–194

Eswaran H., Van den Berg E., Reich P. and Kimble J. (1995). Global soil carbon resources. In: Lal R., Kimble J., Levine E. and Stewart B.A. (Eds) *Soil and global change*.. CRC Press, Boca Raton, FL, U.S.A., pp 27–43.

Eyhorn F., Heeb M. and Weidmann G. (2004). *IFOAM Training manual for organic agriculture in the tropics. Theory, transparencies and didactic approach*.

Fliessbach A., Oberholzer H., Gunst L. and Paul M. (2007). Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming. *Agriculture, ecosystems and environment*, 118: 273-284.

Fox R.H., Myers R.J.K. and Vallis I. (1990). The nitrogen mineralization rate of legume residues in soil as influenced by their polyphenol, lignin and nitrogen content. *Plant and soil*, 129: 251-259.

Fuchs J. (2003). Alter agri, bimestriel des agricultures alternatives: le parasitisme ovin et caprin. *Le composte de qualité au service de la santé des plantes,* 61: 7-9

Goar G. L. (1934). Vetches and related crops for forage. California agricultural Extension service, college of agriculture, University of California, Circ. 336. November, 1934.

Gonzalez R.F. and Cooperband L.R. (2002). Compost effects on soil physical properties and field nursery production. *Compost science and utilization,* 10: 226-237.

Hanna Y., Colyer P.D., Kirkpatrick T.L., Romaine D.J., and Vernon P.R. (1993). Improving yield of cucumbers in nematode-infested soil by double-cropping with a resistant tomato cultivar, using transplants and nematicides. *Florida state horticulture society*, 106:163-165.

Harizanova V and Ekbom B. (1997). An evaluation of the parasitoid, *Aphidius colemani* Viereck (Hymenoptera: Braconidae) and the predator Aphidoletes *aphidimyza Rondani* (Diptera: Cecidomyiidae) for biological control of *Aphis gossypii Glover* (Homoptera: Aphididae) on cucumber. *Journal of entomological science*, 32(1): 17-24.

Haynes R.J. (1999). Size and activity of the soil microbial biomass under grass and arable management. *Biology and fertility of soils,* 30: 210-216.

HDRA The organic organization (1998). Green manures/cover crops. <http://www.gardenorganic.org.uk/pdfs/international_programme/GreenMan.pdf.>

Heichel G.H. and Barnes D.K. (1984). Opportunities for meeting crop nitrogen needs form symbiotic nitrogen fixation. In: Bezdicek D.E., Power J F., Keeney D. R. and Wright M L (eds.) *Organic farming: Current technology and its role in a sustainable agriculture*. ASA Spec. Publ. 46. ASA, CSSA, and SSSA, Madison, WI, pp. 49–59.

Herdina L. Silsbury J.H. (1990). Growth, nitrogen accumulation and partitioning, and N-2 fixation in faba bean (*Vicia faba* cv. Fiord) and pea (*Pisum sativum* cv. Early Dun). *Field crops research,* 24:173-188.

Hermann F.J. (1960). *Vetches of the United States - Native, Naturalized, and Cultivated*. Agriculture Handbook No. 168. March, 1960. Superintendent of documents, U.S. government printing office

Hesterman O.B. (1988). Exploiting forage legumes for nitrogen contribution in cropping systems. In: Hargrove W.L. (eds) *Cropping strategies for efficient use of water and nitrogen*. ASA Spec. Publ. 51. ASA, CSSA, and SSSA, Madison, WI, pp.155–166.

Hitchner M.E. and Kuhar P.T. (2005). Squash bug. Virginia cooperative extension. <www.ext.vt.edu/pubs/entomology/444-031/444-031.pdf>.

Hunt P., Smart C. and Eno C. (1973). Sting nematode, *Belanolaninus logicaudatus,* immobility induced by extracts of composted municipal refuse. *Journal of nematology*, 5: 60-63.

Husain M.M., Reid J.B., Othman, H. and Gallagher J.N. (1990). Growth and water use of faba beans (*Vicia faba*) in a sub-humid climate. I. Root and shoot adaptations to drought stress. *Field crops research* 23:1-17.

Ingham E. (2002). *Compost tea-brewing manual*. Third edition. Corvallis,Oregon.

Jackson M.L. (1958). *Soil chemical analysis*. Prentice Hall, Inc. Englewood Cliffs, N. J. Library of Congress, USA.

Jackson M.L. (1967). *Soil chemical analysis*. Prentice Hall of India Privat Limited New Delhi.

James W. R. and Tufekcioglu A. (2000). Vegetation and soil respiration: Correlations and controls. *Biogeochemistry,* 48: 71–90.

Janzen H.H. and Radder G.D. (1989). Nitrogen mineralization in a green manure-amended soil as influenced by cropping history and subsequent crop. *Plant and soil*, 120: 125-131.

Jenkinson D.S., Adams D.E. and Wild A. (1991). Model estimates of CO_2 emissions from soil in response to global warming. *Nature,* 351: 304–306

Kay R.D. and Edwards W.M. (1999). *Farm management*. 4^{th} ed. McGraw Hill, Boston.

Khan Z. and Kim Y.H. (2005). The predatory nematode, *Mononchoides fortidens* (Nematoda: Diplogasterida), suppresses the root-knot nematode, *Meloidogyne arenaria*, in potted field soil. *Biological control*, 35: 78–82.

Kirschbaum M.U.F. (1995). The temperature dependence of soil organic matter decomposition, and the effect of global warming on soil organic C storage. *Soil biology and biochemistry.* 27: 753–760

Koopmans C.J. and Smeding F.W. (2008), A conceptual framework for soil management and its effect on soil biodiversity in organic and low input farming, *16^{th} IFOAM organic world congress, cultivating the future based on science*, Organic crop production, Vol 1, 66-69.

Köpke U. (1996). Legume nitrogen in crop rotation: Reducing losses-increasing precrop effects. *Australian journal of agricultural research*, 8: 32-51.

Koscielniak J., Fliek W. and Grzesiak S. (1989). Influence of soil drought on plant growth, assimilation and dissimilation of CO_2 and accumulation of photosynthates in field bean (*Vicia faba* L. minor)) during pod formation and rapid pod growth. *Journal of agronomy and crop science,* 163: 330-337.

Lampkin N.H., (1994). Organic farming: sustainable agriculture in pactice. In: N.H. Lampkin and S. Padel (Eds), *The economics of organic farming: an international perspective.* Guilford.

Larson B. C., Mossler M.A. and Nesheim O. N. (2000). Florida crop and pest management profiles. University of Florida extension. edis.ifas.ufl.edu/pdffiles/PI/PI03900.pdf>.

Lynch D. H., Voroney R. P. and Warman P. R. (2005). *Soil physical properties and organic matter fractions under forages receiving composts, manure or fertilizer*. Organic agriculture centre of Canada, Department of plant and animal sciences.

Madson B. A. (1951). *Winter cover crops*, circular 174, California agricultural extension service, College of agriculture, University of California. June 1951.

Mayer J., Scheid S. and Oberholzer H.R., (2008). How effective are 'Effective microorganisms'? Results from an organic farming field experiment, *16th IFOAM organic world congress, cultivating the future based on science*, Organic crop production, Vol 1, 168-171.

McLeod. (1982). Feed the soil. Organic agriculture research institute, Graton, CA..

Miller P.R., Graves W.L., Williams W.A. and Madson B.A. (1989). *Covercrops for California Agriculture*. University of California Division of Agriculture and Natural Resources, Oakland, California. Leaflet 21471. 24 pp.

Miller R. (1988). *Legume cover crops for Northern California*. Small farm news, Small farm center*, UC Coop. Ext., UC Davis*, July/August 1988

Mohamed Y. F., (2007). Effects of different soil building crops and different fertilization programs on zucchini in Mediterranean organic farming: South Italy case, IAMB, Valenzano. Master thesis: Mediterranean organic agriculture, 489.

Molinar R., Aguiar J., Gaskell M. and Maybemy K. (2000). *Summer squash production in California*. Division of agriculture and natural resources. UC ANR. Publication, 7245. <http://anrcatalog.ucdavis.edu/pdf/7245.pdf>.

Munoz F. and Graves W.L. (1988) Legumes for Orchard, Vegetable and Cereal Cropping Systems. Small Farms, U.C. Coop, Ext., San Diego County ORG. AG. *Legume*s, 488-6/87

Nazik C. A., (2007). Effect of rotation and fertilization on tomato in the Mediterranean organic farming system: case of Turkey, IAMB, Valenzano. Master thesis: Mediterranean organic agriculture, 489.

Nisen A. (1998). Cultures protégées en climat Méditerranéen. Fao, Rome. *Etude production végétale et protection des plantes*, 90.

Osborne L. S. and Landa Z. (1992). Biological control of whiteflies with entomopathogenic fungi*. Florida entomologist*, 75: 456-471.

Owen J., LeBlanc, S. and Fillmore, S.A.E., (2008), Season-long supply of plant-available nutrients from compost and fertiliser in a long-term organic vs. conventional snap bean rotations experiment, *16th IFOAM organic world congress, cultivating the future based on science*, Organic crop production, Vol 1, 74-77.

Ozores-Hampton M., Schaffer B., Bryan H.H. and Hanlon E.A. (1994). Nutrient concentrations, growth and yield of tomato and squash in municipal solid waste amended soil. *Horticultural Science*, 29:785-788.

Paris H. S., (2000). *Horticultural Reviews*, Volume 25, Jules Janick (Eds) 2001 John Wiley & Sons, Inc.

Peaceful Valley Farm Supply. (1988) *Peaceful Valley Farm Supply*. Peaceful Valley Farm Supply, P.O. Box 2209, Nevada City, CA.

Pears P, Dalton R. and Midgely T. (1989). *Step By Step Organic Gardening: Gardening With Green Manures*. Henry Doubleday Research Association , Newsletter 117.

Porter G.A., Opena G.B., Bradbury W.B., McBurnie J.C. and Sisson J.A. (1999). Soil management and supplemental irrigation effects on potato: I. Soil properties, tuber yield, and quality. *Agronomy Journal*, 91: 416-425.

Postma J., Montanari M. and van den Boogert Paul H.J.F. (2003). Microbial enrichment to enhance the disease suppressive activity of compost. *European journal of soil biology*. 39: 157-163.

Raich J. W. and Schlesinger W.H. (1992). The global carbon dioxide flux in soil respiration and its relationship to vegetation and climate. *Tellus*, 44B: 81–99.

Raich J.W. and Potter C.S. (1995). Global patterns of carbon dioxide emissions from soils. *Global Biogeochemistry*. 9: 23–36.

Ramadan M.H.M. (2006). Different organic fertilizer effects organically cultivated broccoli. (*Brassica oleracea* var. *italica*). IAMB, Valenzano. Master thesis: Mediterranean organic agriculture, 443.

Rhoades J. D. (1982). Soluble salts. p. 167-179. *In*: . Page A. L. (ed.). *Methods of soil analysis: Part 2: Chemical and microbiological properties*. Monograph Number 9 (Second Edition). ASA, Madison, WI.

Risse M. and Faucette B. (2001). Compost utilization for erosion control. Cooperative Extension Service. College of Agricultural and Environmental Sciences. Bulletin 1200.

Rizvi, S. J. H., M. Tahir, V. Rizvi, R. K. Kohli, and A. Ansari. 1999. Allelopathic Interactions in Agroforestry Systems. *Critical Reviews in Plant Sciences* 18: 773-779.

Roberts P. and Kucharek T. (2007). Florida plant disease management guide: squash. <edis.ifas.ufl.edu/pdffiles/PG/PG05500.pdf>.

Robson M. (2000). *Compost Tea: A Renewed Ancient Idea*. Washington State University, available at <http://gardening.wsu.edu/column/11-12-00.htm>

Roth G.W. (1996). Crop rotation and conservation tillage. Pennsylvania State University. Conservation tillage. Series 1. <http://cropsoil.psu.edu/extension/ct/uc124.pdf>.

Ryall A.L. and W.J. Lipton, (1979). Handling, Transportion and Storage of Fruits and Vegetables. Vol. 1. Vegetables and Melons. AVI, Westport CT.

Rynk R. M., Van de Kamp G., Willson G., Singley M.E., Richard T.L., Kolega J.J., Gouin F.R., Laliberty J R., Kay D. D, Hoitink H. A. and Brinton W. F. (1992). On-farm composting handbook. In: Rynk R. (eds). *Natural resource, agriculture and engineering service.* Ithaca, New York.

Sarapatka B., Pokorny E., Hejatkova K., Matlova V., and Krskova M. (2006). An evaluation of selected soil properties and their effect on the biological activity of soils in organic farming in the Czech Republic. *Joint Organic Congress, Odense, Denmark, May 30-31, 2006*.

Schenk S.U. and Werner D. (1991) Beta-(3-isoxazolin-5-on-2yl)-alanine from Pisum: allelopathic properties and antimycotic bioassay. *Phytochemistry,* 30:467-470.

Scheuerell S. (2002). *Compost teas and compost amended container media*. Ph.D. Dissertation. Oregon State University, Corvallis, OR.

Schleser G.H. (1982). *The response of CO2 evolution from soils to global temperature changes*. Zeitschrift für naturforschung 37a: 287–291

Schoneweis S. (2005). *Vegetables report. Department of horticulture*. University of Nebraska-Lincoln.

Sebti E.K. (2005). *Compost tea effects on soil fertility and plant growth of organic tomato* (*Solanum lycopersicon Mill*) *in comparison with different organic fertilizers*. IAMB, Valenzano. Master thesis: Mediterranean organic agriculture, 403.

Semple E.C. (1928). Ancient Mediterranean agriculture: II. Manuring and seed selection. *Agricultural history*, 2: 129-156.

Siddiqui I. A. and Shaukat S. S. (2002). Rhizobacteria-mediated induction of systemic resistance in tomato against *Meloidogyne javanica*. *Phytopathology,* 150: 469–473.

Smith M.S., Frye W.W. and Varco J. J. (1987). Legume winter cover crops. *Advances in Soil Science* 7: 95-139

Smith P. and Doubrava N. (2003). Broccoli. <http://hgic.clemson.edu/factsheets/HGIC1301.htm>

Snaders D. C. (2001). *Broccoli Production* <http://www.ces.ncsu.edu/depts/hort/hil/hil-5.html>

Stansly P.A. (1995). Seasonal abundance of silverleaf whitefly in southwest florida vegetable fields. *Proceedings of the Florida State Horticultural Society,* 108: 234-242.

Stoffella P.J., Li Y., Roe N. E., Ozores-Hampton M. and Graetz D. A. (1996). Utilization of organic waste composts in vegetable crop production systems. In: *Managing soil fertility for intensive vegetable production systems in Asia*, Proceedings of an international conference, Tainan County, Taiwan.

Sundheim L. (1982). Control of cucumber powdery mildew by the hyperparasite *Ampelomyces quisqualis* and fungicides. *Plant pathology*, 31 (3): 209–214.

Suslow T.V. and Cantwell M., (1998). *Squash (soft rind). Fresh produce facts*. http://postharvest.ucdavis.edu.

Thomopoulos P., Bilalis D., Konstantas A. and Efthimiadou A., (2008). The effect of gren manure on root development and cotton yield under Mediterranean conditions, *16th IFOAM organic world congress*, cultivating the future based on science, Organic crop production, Vol 1, 211-214.

Vantine M. and Verlinden S. (2003). Maintaining soil fertility under an organic management system. West Virginia University. SARE Northeast region: sustainable agriculture research and education program. <http://www.wvu.edu/~agexten/farmman2/organic/soilfert.pdf>.

Watson C.A., Atkinson D., Gosling P., Jackson L.R. and Rayns F.W. (2002). Managing soil fertility in organic farming systems. *Soil use and management*, 18: 239-247.

Wayne J. McLaurin, J. M., Paul C. and Darbie M. G., (1998). Broccoli production guide for Western North Carolina. <http://www.ces.ncsu.edu/depts/hort/hil/hil-5b.html>

Welke S.E. (2001). Effectiveness of compost tea extracts as disease suppressants in fresh market crops. *Research review*, 9.

ANNEXES

Annex 1

Broccoli - Zucchini - Compost tea

Date (mm/dd/yy)	Activity**	Item description	Costs – Inputs – Units (kg, l, m³, n.)	Inputs – Quantity/Replicate* – Replicate 1	Inputs – Replicate 2	Inputs – Replicate 3	Inputs – Replicate 4	Inputs – price/unit (€, $)	Inputs – Average	Costs – Labour – Time Unit (min, hour)	Labour – Time – Replicate 1	Labour – Replicate 2	Labour – Replicate 3	Labour – Replicate 4	Labour – price/unit (€, $)	Labour – Average	Benefits – Output – Units (kg, l, m³, n.)	Output – Quantity/Replicate – Replicate 1	Output – Replicate 2	Output – Replicate 3	Output – Replicate 4	Output – price/unit (€, $)	Output – Average
Aug. 28/07	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
Sept. 15/07	Transplanting	6 male labors (1hour male labor =2,5€)	n.	120	120	120	120	0,04 €	4,94 €	hour	0,33	0,33	0,33	0,33	2,50 €	0,83 €							
Sept. 15/07	Irrigation	Drip irrigation system used for 3 hours	m^3	0,15	0,15	0,15	0,15	0,07 €	0,01 €														
Sept. 21/07	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,50	0,50	0,50	0,50	1,83 €	0,92 €							
Oct. 15/07	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,50	0,50	0,50	0,50	1,83 €	0,92 €							
Dec. 12/07	Harvest	2 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								hour	0,08	0,08	0,12	0,12	2,50 €	0,25 €	kg	1,89	1,91	2,32	2,76	0,59 €	1,31 €
Dec. 17/07	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								hour	0,33	0,33	0,33	0,33	2,50 €	0,83 €	kg	16,25	24,15	24,77	25,25	0,59 €	13,34 €
Jan. 11/08	Harvest	2 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								hour	0,25	0,25	0,25	0,25	2,50 €	0,63 €	kg	14,15	15,15	10,63	10,54	0,59 €	7,44 €
Jan. 29/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,08	0,07	0,08	0,08	2,50 €	0,20 €	kg	1,59	0,61	1,25	1,24	0,59 €	0,69 €
Feb. 20/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,12	0,12	0,13	0,13	2,50 €	0,31 €	kg	2,58	2,67	3,12	3,78	0,59 €	1,79 €
Mar. 05/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,13	0,13	0,13	0,13	2,50 €	0,33 €	kg	3,35	4,25	3,78	4,35	0,59 €	2,32 €
Mar. 19/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,13	0,13	0,13	0,13	2,50 €	0,33 €	kg	4,56	3,45	4,12	3,20	0,59 €	2,26 €
Apr. 04/08	Soil preparation	cutting of the broccoli plants to prepare for incorporation								hour	0,40	0,40	0,40	0,40	2,50 €	1,00 €							
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours								hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,004 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,004 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	2,00	3,00	2,00	5,00	0,03 €	0,09 €	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €							
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m^3	1,70	1,70	1,70	1,70	0,07 €	0,12 €														
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €														
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour. 500 g of sulfur were applied in total	kg	0,02	0,02	0,02	0,02	2,75 €	0,04 €	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €							
			hour	0,09	0,09	0,09	0,09	5,30 €	0,50 €														
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours								hour	0,25	0,25	0,25	0,25	1,83 €	0,46 €							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	1,12	0,87	0,89	1,12	1,83 €	1,83 €	kg	10,98	8,02	8,40	11,44	1,00 €	9,71 €
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m^3	2,50	2,50	2,50	2,50	0,07 €	0,18 €														
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	2,53	2,42	2,43	2,33	1,83 €	4,44 €	kg	63,16	52,27	53	46,07	1,00 €	53,63 €
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
July. 01-30/08	Fertigation	200 lt of compost tea applied to the experimental field at weekly intervals	kg	1,25	1,25	1,25	1,25	0,35 €	0,44 €														
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,89	0,23	0,45	0,39	1,83 €	0,90 €	kg	11,58	3,83	7,27	7,35	1,00 €	7,51 €
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														

Broccoli - Zucchini - Commercial Fertilizer

			Costs														Benefits						
Date (mm/dd/yy)	Activity**	Item description	Inputs							Labour							Output						
			Units (kg, l, m^3, n.)	Quantity/Replicate*				price/unit (€, $)	Average	Time Unit (min, hour)	Time				price/unit (€, $)	Average	Units (kg, l, m^3, n.)	Quantity/Replicate				price/unit (€, $)	Average
				Replicate 1	Replicate 2	Replicate 3	Replicate 4				Replicate 1	Replicate 2	Replicate 3	Replicate 4				Replicate 1	Replicate 2	Replicate 3	Replicate 4		
Aug. 28/07	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
Sept. 15/07	Transplanting	6 male labors (1hour male labor =2,5€)	n.	120,00	120,00	120,00	120,00	0,04 €	4,94 €	hour	0,33	0,33	0,33	0,33	2,50 €	0,83 €							
Sept. 15/07	Irrigation	Drip irrigation system used for 3 hours	m^3	0,15	0,15	0,15	0,15	0,07 €	0,01 €														
Sept. 21/07	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,50	0,50	0,50	0,50	1,83 €	0,92 €							
Oct. 15/07	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,50	0,50	0,50	0,50	1,83 €	0,92 €							
Dec. 12/07	Harvest	2 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								hour	0,12	0,12	0,12	0,12	2,50 €	0,29 €	kg	2,16	2,15	2,29	2,58	0,59 €	1,35 €
Dec. 17/07	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								hour	0,33	0,33	0,33	0,33	2,50 €	0,83 €	kg	19,01	21,25	26,64	26,78	0,59 €	13,82 €
Jan. 11/08	Harvest	2 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								hour	0,33	0,25	0,25	0,18	2,50 €	0,64 €	kg	20,02	11,88	10,84	6,87	0,59 €	7,32 €
Jan. 29/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,08	0,08	0,08	0,08	2,50 €	0,21 €	kg	1,44	1,13	1,74	0,61	0,59 €	0,73 €
Feb. 20/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,12	0,13	0,13	0,13	2,50 €	0,32 €	kg	2,35	3,65	4,12	3,20	0,59 €	1,96 €
Mar. 05/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,13	0,13	0,13	0,13	2,50 €	0,33 €	kg	4,12	3,12	3,95	3,45	0,59 €	2,16 €
Mar. 19/08	Harvest	1 male labors. Harvested broccolis are sold directly to the consumer without the organic premium								Hour	0,13	0,13	0,13	0,13	2,50 €	0,33 €	kg	3,15	4,65	3,45	4,24	0,59 €	2,28 €
Apr. 04/08	Soil preparation	cutting of the broccoli plants to prepare for incorporation								hour	0,40	0,40	0,40	0,40	2,50 €	1,00 €		0,00	0,00	0,00	0,00	0,00	0,00
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours								hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	2,00	4,00	1,00	6,00	0,03 €	0,10 €	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €							
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m^3	1,70	1,70	1,70	1,70	0,07 €	0,12 €														
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €														
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor. Tractor	kg	0,02	0,02	0,02	0,02	2,75 €	0,04 €	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €							
		renting price which includes the wage for the driver is	hour	0,09	0,09	0,09	0,09	5,30 €	0,50 €														
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours									0,25	0,25	0,25	0,25	1,83 €	0,46 €							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,39	0,42	0,45	0,21	1,83 €	0,67 €	kg	9,09	12,85	10,38	7,46	1,00 €	9,95 €
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m^3	2,50	2,50	2,50	2,50	0,07 €	0,18 €														
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour									0,13	0,13	0,13	0,13	1,83 €	0,23 €							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	2,02	1,98	2,11	1,57	1,83 €	3,51 €	kg	53,85	50,24	54,45	44,40	1,00 €	50,74 €
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
July. 01-30/08	Fertigation	250gr of Pow Humus applied to the experimental field for three times at weekly intervals	kg	0,75	0,75	0,75	0,75	17,00 €	12,75 €														
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,42	0,34	0,57	0,21	1,83 €	0,70 €	kg	9,27	7,10	9,35	4,66	1,00 €	7,60 €
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														

Vetch - Zucchini - Compost tea

Date (mm/dd/yy)	Activity**	Item description	Costs														Benefits						
			Inputs							Labour							Output						
			Units (kg, l, m^3, n.)	Quantity/Replicate*				price/unit (€, $)	Average	Time Unit (min, hour)	Time				cost/unit (€, $)	Average	Units (kg, l, m^3, n.)	Quantity/Replicate				price/unit (€, $)	Average
				Replicate 1	Replicate 2	Replicate 3	Replicate 4				Replicate 1	Replicate 2	Replicate 3	Replicate 4				Replicate 1	Replicate 2	Replicate 3	Replicate 4		
Aug. 28/07	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
Dec. 07/07	Soil preparation	Ploughing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
Dec. 25/07	Soil preparation	Disk harrowing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,69 €														
Dec. 26/07	Seeding	Seeding the vetch and the preperation of the sub-plots	kg	0,30	0,30	0,30	0,30	0,80 €	0,24 €	hour	0,50	0,50	0,50	0,50	2,50 €	1,25 €							
Apr. 15/08	Soil preparation	cutting of the vetch to prepare for incorporation with the weeding machine (total cost for machine)	hour	0,25	0,25	0,25	0,25	3,00 €	0,75 €														
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours								hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	1,00	3,00	2,00	3,00	0,03 €	0,07 €	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €							
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m^3	1,70	1,70	1,70	1,70	0,07 €	0,12 €														
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €														
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor. Tractor renting price which includes the wage for the driver is	(Sulfur) kg (Tractor) hour	0,02 0,09	0,02 0,09	0,02 0,09	0,02 0,09	2,75 € 5,30 €	0,04 € 0,50 €	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €							
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours								hour	0,25	0,25	0,25	0,25	1,83 €	0,46 €							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,57	0,63	0,72	0,58	1,83 €	1,14 €	kg	9,50	9,65	12,67	9,10	1,00 €	10,23 €
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m^3	2,50	2,50	2,50	2,50	0,07 €	0,18 €														
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	2,10	1,82	2,10	1,98	1,83 €	3,66 €	kg	59,73	44,59	57,6	54,02	1,00 €	53,99 €
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
July. 01-30/08	Fertigation	200 lt of compost tea applied to the experimental field at weekly intervals	kg	1,25	1,25	1,25	1,25	0,35 €	0,44 €														
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,53	0,89	0,49	0,46	0,45 €	0,27 €	kg	8,37	9,13	6,10	5,71	1,00 €	7,33 €
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														

Vetch - Zucchini - Commercial Fertilizer

			Costs														Benefits						
			Inputs							Labour							Output						
Date (mm/dd/yy)	Activity**	Item description	Units (kg, l, m³, n.)	Quantity/Replicate Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average	Time Unit (min, hour)	Time Replicate 1	Replicate 2	Replicate 3	Replicate 4	cost/unit (€, $)	Average	Units (kg, l, m³, n.)	Quantity/Replicate* Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average
Aug. 28/07	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
Dec. 07/07	Soil preparation	Ploughing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
Dec. 25/07	Soil preparation	Disk harrowing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,69 €														
Dec. 26/07	Seeding	Seeding the vetch and the preperation of the sub-plots	kg	0,30	0,30	0,30	0,30	0,80 €	0,24 €	hour	0,50	0,50	0,50	0,50	2,50 €	1,25 €							
Apr. 15/08	Soil preparation	cutting of the vetch to prepare for incorporation with the weeding machine (total cost for machine)	hour	0,25	0,25	0,25	0,25	3,00 €	0,75 €														
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours								hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	3,00	4,00	1,00	6,00	0,03 €	0,11 €	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €							
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m^3	1,70	1,70	1,70	1,70	0,07 €	0,12 €														
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €														
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour. 500 g of sulfur were applied in total	(Sulfur) kg	0,02	0,02	0,02	0,02	2,75 €	0,04 €	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €							
			(Tractor) hour	0,09	0,09	0,09	0,09	5,30 €	0,50 €														
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours									0,25	0,25	0,25	0,25	1,83 €	0,46 €							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,66	0,43	0,66	0,68	1,83 €	1,11 €	kg	12,32	7,64	12,70	13,30	1,00 €	11,49 €
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m^3	2,50	2,50	2,50	2,50	0,07 €	0,18 €														
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour									0,13	0,13	0,13	0,13	1,83 €	0,23 €							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	2,18	1,92	2,20	2,06	1,83 €	3,82 €	kg	64,04	44,17	70,57	55	1,00 €	58,45 €
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
July. 01-30/08	Fertigation	250gr of Pow Humus applied to the experimental field for three times at weekly intervals	kg	0,75	0,75	0,75	0,75	17,00 €	12,75 €														
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,48	0,52	0,64	0,64	1,83 €	1,04 €	kg	6,10	5,94	6,83	6,94	1,00 €	6,45 €
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														

Faba bean - Zucchini - Compost tea

			Costs														Benefits						
			Inputs							Labour							Output						
Date (mm/dd/yy)	Activity**	Item description	Units (kg, l, m³, n.)	Quantity/Replicate* Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average	Time Unit (min, hour)	Time Replicate 1	Replicate 2	Replicate 3	Replicate 4	cost/unit (€, $)	Average	Units (kg, l, m³, n.)	Quantity/Replicate Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average
Aug. 28/07	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
Dec. 07/07	Soil preparation	Ploughing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
Dec. 25/07	Soil preparation	Disk harrowing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,69 €														
Dec. 26/07	Seeding	Seeding the faba bean and the preperation of the sub-plots	kg	0,375	0,375	0,375	0,375	3,00 €	1,13 €	hour	0,50	0,50	0,50	0,50	2,50 €	1,25 €							
Mar. 28/08	Weeding	weed management with 8 male labour								hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
Apr. 17/08	Harvest	1 male labor. Harvested Faba beans are sold directly to the consumer without the organic premium								hour	0,27	0,30	0,25	0,30	2,50 €	0,70 €		1,61	1,91	1,37	2,01	1,00 €	1,73 €
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours								hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	2,00	3,00	1,00	5,00	0,03 €	0,08 €	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €							
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m^3	1,70	1,70	1,70	1,70	0,07 €	0,12 €														
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €														
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor. Tractor renting price which includes the	(Sulfur) kg (Tractor) hour	0,02 0,09	0,02 0,09	0,02 0,09	0,02 0,09	2,75 € 5,30 €	0,04 € 0,50 €	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €							
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours								hour	0,25	0,25	0,25	0,25	1,83 €	0,46 €							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,82	0,87	0,89	0,93	1,83 €	1,61 €	kg	7,89	7,95	8,81	10,02	1,00 €	8,67 €
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m^3	2,50	2,50	2,50	2,50	0,07 €	0,18 €														
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	1,72	1,83	1,87	1,86	1,83 €	3,33 €	kg	54,34	52,28	55,6	54,08	1,00 €	54,08 €
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
July. 01-30/08	Fertigation	200 lt of compost tea applied to the experimental field at weekly intervals	kg	1,25	1,25	1,25	1,25	0,35 €	0,44 €														
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,46	0,42	0,32	0,29	1,83 €	0,68 €	kg	7,53	7,57	4,76	4,45	1,00 €	6,08 €
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														

Faba bean - Zucchini - Commercial Fertilizer

Date (mm/dd/yy)	Activity**	Item description	Costs: Inputs: Units (kg, l, m³, n.)	Quantity/Replicate*: Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average	Labour: Time Unit (min, hour)	Time: Replicate 1	Replicate 2	Replicate 3	Replicate 4	cost/unit (€, $)	Average	Benefits: Output: Units (kg, l, m³, n.)	Quantity/Replicate: Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average
Aug. 28/07	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
Dec. 07/07	Soil preparation	Ploughing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
Dec. 25/07	Soil preparation	Disk harrowing: with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,69 €														
Dec. 26/07	Seeding	Seeding the faba bean and the preperation of the sub-plots	kg	0,375	0,375	0,375	0,375	3,00 €	1,13 €	hour	0,50	0,50	0,50	0,50	2,50 €	1,25 €							
Mar. 28/08	Weeding	weed management with 8 male labour								hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
Apr. 17/08	Harvest	1 male labor. Harvested Faba beans are sold directly to the consumer without the organic premium								hour	0,25	0,25	0,20	0,25	2,50 €	0,59 €	kg	1,28	1,28	0,9	1,33	1,00 €	1,20 €
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours								hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	2,00	1,00	2,00	4,00	0,03 €	0,07 €	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €							
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m^3	1,70	1,70	1,70	1,70	0,07 €	0,12 €														
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €														
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor. Tractor renting price which includes the	(Sulfur) kg (Tractor) hour	0,02 0,09	0,02 0,09	0,02 0,09	0,02 0,09	2,75 € 5,30 €	0,04 € 0,50 €	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €							
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours									0,25	0,25	0,25	0,25	1,83 €	0,46 €							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,34	0,34	0,41	0,44	1,83 €	0,70 €	kg	7,39	11,59	9,75	12,59	1,00 €	10,33 €
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m^3	2,50	2,50	2,50	2,50	0,07 €	0,18 €														
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour									0,13	0,13	0,13	0,13	1,83 €	0,23 €							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	2,10	2,13	2,21	2,21	1,83 €	3,96 €	kg	62,66	54,78	45,82	60,78	1,00 €	56,01 €
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
July. 01-30/08	Fertigation	250gr of Pow Humus applied to the experimental field for three times at weekly intervals	kg	0,75	0,75	0,75	0,75	17,00 €	12,75 €														
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,38	0,39	0,24	0,41	1,83 €	0,65 €	kg	7,61	7,36	5,84	8,91	1,00 €	7,43 €
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														

Fallow - Zucchini - Compost tea

Date (mm/dd/yy)	Activity**	Item description	Costs															Benefits							
			Inputs							Labour								Output							
			Units (kg, l, m³, n.)	Quantity/Replicate*				price/unit (€, $)	Average	Time Unit (min, hour)	Time				cost/unit (€, $)	Average	Units (kg, l, m³, n.)	Quantity/Replicate				price/unit (€, $)	Average
				Replicate 1	Replicate 2	Replicate 3	Replicate 4				Replicate 1	Replicate 2	Replicate 3	Replicate 4				Replicate 1	Replicate 2	Replicate 3	Replicate 4		
Apr. 15/08	Soil preparation	cutting of the natural vegetation to prepare for incorporation with the weeding machine (total cost for machine)	hour	0,25	0,25	0,25	0,25	3,00 €	0,75 €														
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €														
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €							
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours								hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €							
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	2,00	3,00	4,00	6,00	0,03 €	0,11 €	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €							
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m³	1,70	1,70	1,70	1,70	0,07 €	0,12 €														
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €														
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor. Tractor	(Sulfur) kg	0,02	0,02	0,02	0,02	2,75 €	0,04 €	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €							
		renting price which includes the wage for the driver is	(Tractor) hour	0,09	0,09	0,09	0,09	5,30 €	0,50 €														
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours								hour	0,25	0,25	0,25	0,25	1,83 €	0,46 €							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,56	0,62	0,66	0,78	1,83 €	1,20 €	kg	6,76	7,98	9,20	11,00	1,00 €	8,74 €
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m³	2,50	2,50	2,50	2,50	0,07 €	0,18 €														
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour								hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	1,89	1,92	1,80	1,89	1,83 €	3,43 €	kg	44,53	54,18	44,06	48,22	1,00 €	47,75 €
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m³	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
July. 01-30/08	Fertigation	200 lt of compost tea applied to the experimental field at weekly intervals	kg	1,25	1,25	1,25	1,25	0,35 €	0,44 €														
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)								hour	0,42	0.48	0,38	0,57	1,83 €	0,84 €	kg	7,45	7,03	5,74	9,30	1,00 €	7,38 €
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m³	2,55	2,55	2,55	2,55	0,07 €	0,18 €														
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €														

Fallow - Zucchini - Commercial Fertilizer

Costs – Inputs

Date (mm/dd/yy)	Activity**	Item description	Units (kg, l, m³, n.)	Quantity/Replicate* Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average
Apr. 02/08	Soil preparation	cutting of the natural vegetation to prepare for incorporation with the weeding machine (total cost for machine)	hour	0,25	0,25	0,25	0,25	3,00 €	0,75 €
May. 06/08	Soil preparation	Ploughing: with 70HP tractor to prepare the soil for seeding zucchini	hour	0,10	0,10	0,10	0,10	5,30 €	0,53 €
May. 07/08	Soil preparation	Disk harrowing with 70HP tractor. Tractor renting price which includes the wage for the driver is 5,30€ per hour	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €
May. 07/08	Seeding	Preperation of the plots and seeding of the zucchini with 6 male labors for 5 hour (for the total work)	kg	0,12	0,12	0,12	0,12	5,00 €	0,60 €
May. 08/08	Other	Establishment of the drip irrigation system by 2 male labors for 3 hours							
May. 20/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €
May. 22/08	Weeding	2 female labors (1 hour female labor=1,83€)							
May. 29/08	Pest management	application of 15litre (for all the plots with consantration of 2,5ml/10l) neemazal for the white flies control by 1 male labor for 3 hours	l	0,00012	0,00012	0,00012	0,00012	30,00 €	0,0036000 €
May. 31/08	Transplanting	Transplanting zucchini seedlings to the empty spots	n	3,00	1,00	2,00	6,00	0,03 €	0,09 €
May. 1to31/08	Irrigation	Total irrigation for may. Drip irrigation system used for 34 hours. Generaly irrigations are done 3 times a week	m^3	1,70	1,70	1,70	1,70	0,07 €	0,12 €
June. 04/08	Fertilization	application of 6kg/sub-plot compost (biofarm) by 2 male labors in 2 hour	kg	6,00	6,00	6,00	6,00	0,35	2,10 €
June. 05/08	Weeding	to incorperate the compost, hoeing done by 2 female labors for 3 hours							
June. 25/08	Pest management	Wetable Sulfur applied by 70HP tractor.	(Sulfur) kg	0,02	0,02	0,02	0,02	2,75 €	0,04 €
		Tractor renting price which includes the	(Tractor) hour	0,09	0,09	0,09	0,09	5,30 €	0,50 €
June. 28/08	Weeding	hoeing done by 2 female labors for 8 hours							
June. 01-30/08	Harvest	Harvests start at 21st of june and done 3 times a week on Mondays, Wednesdays and Fridays. 5 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)							
June. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 50 hours. Generaly irrigations are done 3 times a week	m^3	2,50	2,50	2,50	2,50	0,07 €	0,18 €
July. 17/08	Weeding	hoeing done by 2 female labors for 3 hour							
July. 01-30/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 13 harvestes have been done in june by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)							
July. 01-30/08	Irrigation	Total irrigation for june. Drip irrigation system used for 51 hours. Generaly irrigations are done 3 times a week	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €
July. 01-30/08	Fertigation	250gr of Pow Humus applied to the experimental field for three times at weekly intervals	kg	0,75	0,75	0,75	0,75	17,00 €	12,75 €
Aug. 01-11/08	Harvest	Harvests done 3 times a week on Mondays, Wednesdays and Fridays. 2 harvestes have been done in August by female labors. (consumer price for organic zucchini in Turkey is considered as selling price.)							
Aug. 01-11/08	Irrigation	Total irrigation for August. Drip irrigation system used for 28 hours.	m^3	2,55	2,55	2,55	2,55	0,07 €	0,18 €
Aug. 11/08	Other	Disk Harrowing for incorporation of the zucchini - 2 hours - 70HP tractor	hour	0,13	0,13	0,13	0,13	5,30 €	0,66 €

Costs – Labour

Date (mm/dd/yy)	Time Unit (min, hour)	Time Replicate 1	Replicate 2	Replicate 3	Replicate 4	cost/unit (€, $)	Average
Apr. 02/08							
May. 06/08							
May. 07/08							
May. 07/08	hour	1,00	1,00	1,00	1,00	2,50 €	2,50 €
May. 08/08	hour	0,16	0,16	0,16	0,16	2,50 €	0,40 €
May. 20/08	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €
May. 22/08	hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €
May. 29/08	hour	0,01	0,01	0,01	0,01	2,50 €	0,03 €
May. 31/08	hour	0,10	0,10	0,10	0,10	2,50 €	0,25 €
May. 1to31/08							
June. 04/08							
June. 05/08	hour	0,13	0,13	0,13	0,13	1,83 €	0,23 €
June. 25/08	hour	0,09	0,09	0,09	0,09	2,83 €	0,27 €
June. 28/08		0,25	0,25	0,25	0,25	1,83 €	0,46 €
June. 01-30/08	hour	0,60	0,66	0,72	0,89	1,83 €	1,31 €
June. 01-30/08							
July. 17/08		0,13	0,13	0,13	0,13	1,83 €	0,23 €
July. 01-30/08	hour	2,13	2,31	1,88	1,91	1,83 €	3,77 €
July. 01-30/08							
July. 01-30/08							
Aug. 01-11/08	hour	0,48	0,89	0,31	0,57	1,83 €	1,03 €
Aug. 01-11/08							
Aug. 11/08							

Benefits – Output

Date (mm/dd/yy)	Units (kg, l, m³, n.)	Quantity/Replicate Replicate 1	Replicate 2	Replicate 3	Replicate 4	price/unit (€, $)	Average
June. 01-30/08	kg	10,10	10,93	9,78	12,18	1,00 €	10,75 €
July. 01-30/08	kg	62,18	71,13	47,91	50,49	1,00 €	57,93 €
Aug. 01-11/08	kg	6,20	9,50	3,95	6,41	1,00 €	6,52 €