International Journal of Agriculture and Forestry 2013, 3(6): 220-225
DOI: 10.5923/j.ijaf.20130306.03

Effects of Summer Season Green Manuring on Organic Head Lettuce Production in Greenhouse

Hale Duyar

Bayındır Vocational School, Ege University, Bayındır, İzmir, 35840, Turkey

Abstract This research was carried out to determine the effects of summer season green manuring on winter season organic head lettuce (*Lactuca sativa* var *capitata cv*. Coolguard) production in unheated greenhouse conditions between 2005 and 2007. In the experiment the tested summer green manure plants were (1) soybean (*Gylcine max*. L. Merr.), (2) cowpea *(Vigna sinensis L)*, (3) maize (*Zea mays*). Another parcel was left *as* control (4) without manuring. All of the plots were divided into two parcels and poultry manure was applied as 0 (-PM) and 0.75 kg m^{-2} (+PM) to each one. Experimental design of the study was split plot with 3 replicates. Effects of the treatments on yield, head quality (head height (cm), head diameter (cm), total leaf number (number $plant^{-1}$), nitrate content (mg kg^{-1}) and vitamin C (mg $100g^{-1}$) content of head lettuce together with soil fertility and available plant nutrients was investigated. Yield changed between 5459.7 and 6097.8 g m^{-2}, 4261.5 and 7430.6 g m^{-2} in the first and second years, respectively. Organic matter and nitrogen (N) content of the soil was enhanced by green manuring. Available nutrient content of the head lettuce plants was found in adequate level. Results showed that, due to its additional costs and considering the achieved results, it is not necessary to apply the poultry manure with green manures.

Keywords Soybean, Cowpea, Maize, Poultry Manure, Head Lettuce

1. Introduction

Crop losses occur upon climatic conditions in greenhouses. The excessive use of synthetic chemicals in order to minimize yield losses are harmful to the environment and human health (1). The research has been introduced which adversely affects soil structure and may lead to pollute water recently (2) and the increasing consumer awareness of organic agriculture and creating pressure has increased the importance of organic agriculture in greenhouse.

At high yield greenhouse production monoculture farming of the species is common practice therefore the difficulty of rotation is important for soil fertility. Increasing the amount of organic matter in soil at long term is important (3, 4, 5). One of the ways that by enriching the chemical, biological characteristics of the soil in terms of its organic substance, to prevent erosion and soil moisture is "green manure" (6).

Green manures are plants which are grown to improve the structure and nutrient content of the soil (7, 8, 9, 10). Grains or legumes can be used as green manure. Green manures are usually dug into the soil when the plants are still young, before they produce any crop and often before they flower (3, 7, 9). If grain plants had been used as green manuring, the nitrogen in the soil becomes immobilized, so it can not be used by the plants (11). To prevent this, legumes should be planted mixed or banyard manure added (4, 12, 13). If the aim is to provide necessary nitrogen by organic ways lettuce green plant fertilizer must be used (10, 14). Legume family fixes 34 kg nitrogen per hectare/year (11). Approximately 20-60% of it are used by the next product depending on the climate and soil conditions (5, 11). As a result of symbiotic life, they fix significant amount of atmospheric nitrogen to the soil with Rhizobium bacteries (15, 16, 17). While green manure plants are using top soil nitrogen, the nitrogen in deeper is consumed by plants. However, subsequent mineralization enriches the soil above (4, 5, 10, 15, 18). Due to the effective roots of vegetables are different, an interaction comes out between vegetable types and green manure plants (18, 17).

Since the very early years, many researchers have been made about fertilizing on various field crops and vegetables (4, 5, 10, 19, 20, 21, 22, 23). In this study were(i) to compare summer green manure crops with organically grown head lettuce crop in term of yield, quality and (ii) to evaluate the effect of green manuring on soil fertility.

2. Material and Method

The experiment was conducted in a polyethylene (PE) covered double span greenhouse (12.5 × 25 m) with galvanized construction, Side and the roof of the greenhouse were covered with insect net from 2005 to 2007 in Bornova (38°27′16.5″N, 27°13′16.8″E), İzmir, Turkey. Side and the

* Corresponding author:
hale.duyar@ege.edu.tr (Hale Duyar)
Published online at http://journal.sapub.org/ijaf

roof of the greenhouse was covered by insect net. Since 2000, the greenhouse was used for organic vegetable production, the soil was washed by spraying with water ponding before green manure. Some physical and chemical properties of soil before the green manure was given in Table 1.

Table 1. Some physical and chemical properties of the experimental soil

	1. year	2. year
pH	7.70	7.81
Soluble salts (%)	0.175	0.151
$CaCO_3$ (%)	2.80	2.19
Texture	Clay-loam	Sandy-clay-loam
Organic matter (%)	2.17	2.15
Total N (%)	0.23	0.15
Available P (mg kg^{-1})	5.19	11.57
Available K (mg kg^{-1})	380.00	607.88
Available Ca (mg kg^{-1})	4050.00	3936.25
Available Mg (mg kg^{-1})	1588	582.50
Available Mn (mg kg^{-1})	2.24	22.01
Available Fe (mg kg^{-1})	14.62	7.47
Available Cu (mg kg^{-1})	4.55	4.30
Available Zn (mg kg^{-1})	7.06	8.27

Soybean (*Gylcine max. L. Merr.*), (1), cowpea (*Vigna sinensis L*) (2), maize (*Zea mays*) (3) were used as green manure (GM). Without green manurlng parcel was used as control. 5 weeks after planting the first flowers were observed in soybean and cowpea. In this period, while soybeans and cowpeas stirring the soil, corn was stirred by breaking down when it reached 80-100 cm height. Before head lettuce cultivation, green manure parcels divided in two and in addition to green manure 0.75 kg m^{-2} PM was applied. PM is organic origin in pellet form and provided by Org-E-Vit (ITM Turhol Company, Antalya, Turkey) (Table 2).

Table 2. Some physical and chemical characteristics of pultry manure

O.M (%)	9.96	Total Ca (mg kg^{-1})	35250.0
pH	6.4	Total Mg (mg kg^{-1})	7310.0
EC (µS/m)	5.0	Total Mn (mg kg^{-1})	329.0
Total N (%)	2.69	Total Fe (mg kg^{-1})	1540.0
Total P (mg kg^{-1})	21488.0	Total Cu (mg kg^{-1})	36.0
Total K (mg kg^{-1})	19000.0	Total Zn (mg kg^{-1})	140

In winter, head lettuce (*Lactuca sativa cv. Coolguard*) was cultivated. Both cultivation periods, lettuce seeds were provided from Asgrow company. First year, seedling production was carried out in greenhouses of A.U.A F in the department of Horticulture, and second year in Ege Seedling company in Torbalı, İzmir. 10 seedlings used for each application with three replications according to pattern. Seedlings were planted 50x30x25 cm intervals. Production schedule of the experiment is given in Table 3. Plant maintenance works (25) were conducted.

In the study; total yield (g m^{-2}), head weight (g), marketable plant weight (g) were determined. Head length and wide were measured by ruler in three heads for each replication and leaf number of marketable head were counted.

Table 3. Production Schedule of the experiment

Year	Planting	Harvest
2005-2006	13 Aralık 2005	09 Mart 2006
2006-2007	17 Ekim 2006	10 Ocak 2007

After 0,5 grams of leave sample was homogenized in water for vitamin C content, it was filtered and taken sample after filtering, the sample was stabilized wit oxalic acid for 1%. In the sample taken from this mixture 2-6 diklorofenlindefenol for 0,0012 % was added and absorbance values were read at a wavelength of 518 nm in spectrophotometer. The same readings were made at the standard ascorbic acid solution, and standard solutions prepared with stabilized substance, and standard curves were prepared; absorbance values reading at the samples converted into amounts C by the help of standard curve, and the results were given as mg in g fresh weight (26).

Nitrate content of leaves, the leaves of homogeneously received 95 ml of distilled water 5 g of homogenized and filtered white-band filter paper, filtering the sample mixture onto 5% salicylic acid + sulfuric acid and 4 N NaOH was added, with stirring at 410 nm spectrophotometer reading was taken Standards are also prepared by the same method Curve factor read out and nitrate contents in mg kg^{-1} was calculated (27). Irrigation was performed by drip irrigation method. In order to determine the amount of water required was calculated according to the evaporation values of open water surface, and calculated with ET=Epan x kc x kpan x A (liter) equation

Before the procedures of green manure seed planting (1st Year: 23.7.2005; 2 Year: 19.07.2006), head lettuce planting (1st Year: 12/13/2005, 10/17/2006 2nd year), and head lettuce harvest (1 year: 3.9 .2006; 2nd year: 01/10/2007) the soil was taken from 0-30 depth of the experimental area and brought to the lab and it made wait by putting into cardboards boxes. Afterwards it was ready for analysis by sieving for 2mm diameter and organic substance (29) and total N (30) analysis were processed in these soil samples.

Weekly periodic observations were made so as to intervene the diseases and pests as soon as possible during the cultivation. The temperature and soil temperature in greenhouse was monitored by "hobo data recorder". During the cultivation period greenhouse internal temperature first year: min: 11.50; max: 31,87℃; second year: min: 12.21; max: 30.53℃ and soil temperature, first year: min: 13:94; max; 26:44℃; second year: min: 15.63; max: 25.57℃ values were determined.

According to the data obtained from the research, analysis of variance was carried out using a statistical analysis package program (ANOVA) and the least significant difference (LSD) test was conducted at 5% importance level in order to identify differences between means.

3. Results and Discussion

3.1. Yield Parameters

The effects of green manures on the yield of head lettuce are shown in Table 4. Green manures and PM did not effect the total yield in the first year, but total yield and marketable head weight is found significantly important in the second years. The highest total yield of maize +PM application (7431 g m^{-2}) and control +PM owned and controlled by the rate of 40.79 %, and 44.52 %, respectively, were higher (Table 4).

Table 4. The yield parameters of head lettuce

		First year		Second year	
		TY	MHW	TY	MHW
Soyabean	+PM	6108	534.8	5605	538.2
Cowpea		6078	548.4	4861	465.2
Maize		6308	572.4	7431	703.3
Control		5114	453.8	4400	421.7
LSD 0,05		*ns*	*89.2*	*581.6*	*80.2*
Soyabean	-PM	6088	524,3	5614	515.4
Cowpea		5530	511.1	4506	437.0
Maize		5497	504.0	7431	706.8
Control		5786	507.0	4123	394.5
LSD 0,05		*ns*	*ns*	*582*	*80.2*

TY: Total yield (g m^{-2}); MHW: Marketable head weight (g)

Head lettuce salad-yield varies depending on many factors such as climatic conditions, cultivation period, the number of plants per unit area , yield between 3-4 kg m^{-2} is reported to be good (31). These values to yield values obtained in this study, as well as head lettuce produced in different studies in the same period is similar to the yield, even on some of the remains (32, 33). According to that, organic cultivation was realized without efficiency lost in this study. Having encountered any problems with diseases and pests played great important role. In the second year, the problem of nematod appeared in cowpea and soybean both decreased output of green manure plants and biomass that made mix in the soil and it was determined that efficiency values and total N amounts decreased.

3.2. Quality Parameters

In the first experiment, head height, head diameter and the total number of leaves did not affect applications (Table 5).

In the second experimental year, head height, head diameter, and total number of leaves and application effects were found important. When chicken manure and green manure were used together head height, head diameter and the total number of leaves increased compared to the control application (Table 5). The application effects in head lettuce on nitrate and vitamin C content is given in Table 6. Nitrate content was found higher in plant samples taken from parcels that having to be applied with poultry manure and green manure.

The quality values obtained in this study are similar to head lettuce produced in the same period and different studies (32, 33, 34, 35). High nitrate contents is undesirable in the vegetables for direct human consumption. For this reason, it was focused on nitrate between the parameters regarding to quality characteristics. High nitrate concentration leads to either dismantle of intestinal membrane or vasodilation. It also prevents the transport of oxygen in the blood in young children when transformed from nitrate to nitrite. It is essential to worry about consider high nitrate content of vegetables in abundance, especially in case of nitrate fertilization. It was observed that nitrate amount was higher in the applications of green manure that legume plants were used (7, 36) and also in the parcels with poultry manure as well as in soybean and cowpea applications.

Table 5. Effects of treatments on plant characteristics

		1.year			2. year		
		HH	HD	TNL	HH	HD	TNL
Soyabean	+PM	16.2	14.2	28.1	28.5	19.2	28.8
Cowpea		16.3	14.3	30.9	28.9	18.0	24.8
Maize		17.3	15.0	31.9	29.3	20.2	27.8
Control		16.9	13.8	32.6	25.4	15.4	21.6
LSD 0,05		*ns*	*ns*	*ns*	*3.0*	*3.9*	*3.2*
Soyabean	-PM	16.2	13.0	31.7	24.1	18.0	26.9
Cowpea		17.0	13.1	33.8	24.8	15.7	24.6
Maize		15.3	12.7	29.2	27.2	18.7	25.4
Control		15.5	12.6	32.7	24.8	15.6	21.4
LSD 0,05		*ns*	*ns*	*ns*	*3.0*	*ns*	*3.2*

HH: head height (cm); HD: head diameter (cm); TNL: Total Number of leaf (number $plant^{-1}$)

Table 6. Effect of treatments on nitrate (mg kg-1) and vitamin C content (mg 100 g-1)

		First year		Second year	
		nitrat (mg kg^{-1})	Vit c (mg100 g^{-1})	nitrat (mg kg^{-1})	Vit c (mg100 g^{-1})
Soyabean	+PM	69.0	0.200	87.8	0.295
Cowpea		58.6	0.280	74.5	0.125
Maize		51.8	0.210	33.9	0.245
Control		56.4	0.210	32.8	0.230
LSD 0,05		*10.8*	*ns*	*37.2*	*0.168*
Soyabean	-PM	64.4	0.280	17.0	0.245
Cowpea		81.6	0.180	37.5	0.085
Maize		64.0	0.210	40.3	0.145
Control		40.4	0.210	30.2	0.205
LSD 0,05		*10.8*	*ns*	*ns*	*ns*

3.3. Soil Characteristics

When look at the effects on soil efficiency of head lettuce cultivation following winter green head lettuce manure was considered, organic substance amount in soil samples taken from lettuce cultivation until cultivation period end, first and second year ranged from 2.17-3.60 %,to 1.03-3.87 % respectively, (Figure 1).

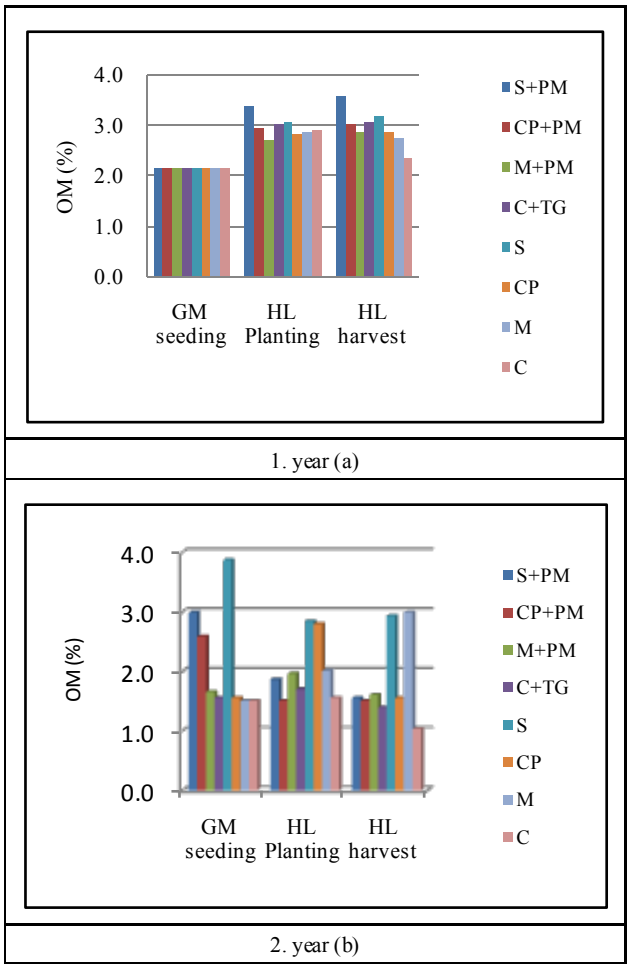

Figure 1. The amount of OM (%) change (1 seed sowing green manure; 2 head lettuce planting, harvest head lettuce 3). (GM:green manuring; HL: head lettuce, S soyabean;CP:cowpea; M mazie; C: control)

According to GM+PM application and control, soil organic substance increased 25.39 % in the first year, and the second year 31.79 % in the first year cultivation. Legumes fixes nitrogen into the soil about 34 kg per hectara year. This is approximately 20-60 % of the (6.8-20.4 kg da-1), depending on climate and soil conditions used by the next product (11). Leguminous crops increased available nitrogen in the soil by breaking down rapidly (4, 5, 10). Since poultry manure is richer in terms of nitrogen content between farm manures, after the application, available nitrogen in soil increases (38). In addition, root depth of the species cultivated is also significant. Owing to head lettuce is shallow root vegetable and has short cultivation period, Green manure plants which are increased available nitrogen on topsoil should be selected (39).

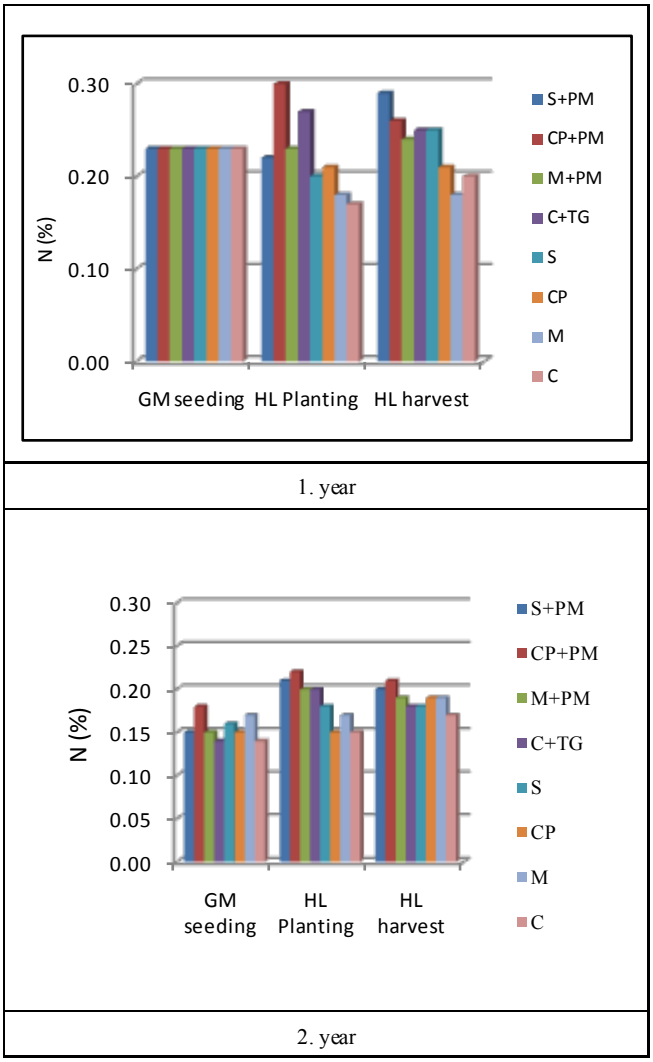

Figure 2. The amount of N (%)change (1 seed sowing green manure; 2 head lettuce planting, harvest head lettuce 3). (GM:green manuring; HL: head lettuce, S soyabean;CP:cowpea; M mazie; C: control)

Total nitrogen was found as 0.23 % in the soil sample taken from planting green manure seeds. Depending upon applications and date samples takentotal N content ranged from 0,17 to 0.30 % and 0.14-0.22 %., in the first and second year, respectively,1 Total N content. In head lettuce harvest, according to average control in PM application increased 24.05%, and according to PM + GM application and control 6.25 %, respectively in the second year 15% and 8% (fig. 3, 4). Using green manure is different from other organic manures in terms of providing N to the crops produced afterwards. Especially legumes provide desired nutrients in nitrogen by means of confining nodosity nitrogenous (40). Green manure plant needs N sources in the soil during their developments, and green manure plants release after removing N from the soil. Therefore, green manure plants is not only available N in the soil, but also affects distribution throughout the soil profile (41). While legume green manure plants using N on topsoil, N in deeper is consumed, however, subsequent mineralization enriches the topsoil (4, 12, 13, 15, 42).

4. Conclusions

As a result, it is determined that summer green manure improve the amount of total N and organic substance of soil, and provides nutrients to the crops after it was grown.

ACKNOWLEDGEMENTS

This project (105O571) was supported by the Scientific and Technological Research Council of Turkey (TÜBİTAK).

REFERENCES

[1] Tüzel, Y., Karaçancı, A., Gül A, Anaç, D., Okur, B., Ongun, A.R., Yoldaş, Z., Madanlar, N., Gümüş, M., Tüzel, İ.H. ve Engindeniz, S., 2004. "Organic cucumber growing in the greenhouse". 2004. *Acta Horticulturae*, 729: 277-280.

[2] Kaplan, M., Sönmez, S. ve Tokmak, S. 1999." Well Water Nitrate Contents of the Antalya-Kemer Region". *Turkish Journal of Agriculture and Forestry* 23: 309-313. (In Turkish)

[3] Zang, M.K. and Fang, L.P., 2007. "Effect of tillage, fertilizer and green manure cropping on soil quality at an abandoned brick making site". *Soil&Tillage Resercah* 93: 87-93.

[4] Campiglia, E., Campiglia, E.,. Caporali, L.P. F,. Radicetti, R., and Mancinelli R, 2010."Hairy vetch (*Vicia villosa* Roth.) cover crop residue management for improving weed control and yield in no-tillage tomato (*Lycopersicon esculentum* Mill.) production". R.*European Journal of Agronomy* vol. 33 issue 2 August, 2010. p. 94-102

[5] Askegaarda, M., Olesen, J.E.,. Rasmussenb, I. A., and Kristensen, K., 2011. "Nitrate leaching from organic arable crop rotations is mostly determined by autumn field management". *Agriculture, Ecosystems and Environment* 142: 149-160

[6] Anaç, D., ve Okur, B., 1996." Soil Fertility Through Natural Ways Improve". Ekolojik Tarım Org. Derneği, Bornova-İZ MİR. (In Turkish).

[7] Açıkgöz, E., 2001"Forage crops". Uludağ Üniversitesi Güçlendirme Vakfı Yayınları: 182, Bursa. (In Turkish)

[8] Beşirli, G., 2003. "Rotation Organic Vegetable Production, Product Ranking With Production Systems".. www.bahce. biz/organik/organik_ sebze.htm.-47k (accessed: 28.04.2005). (In Turkish).

[9] Soyergin, S., 2006. "Protection of soil fertility in organic farming, organic fertilizers and soil improvers". Sustainable Organic Agriculture Sector Sectoral Strategies and Applications. 222-246. (In Turkish).

[10] Stagnari, F. And Pisante, M. 2010"Managing faba bean residues to enhance the fruit quality of the melon (*Cucumis melo* L.) crop". *Scientia Horticulturae* 126(3) 317-323.

[11] Kavdır, Y., Çetin, S. C., Öztürkmen, A.R., and Öztürk, H.S., 2006. "The importance of soil quality in organic farming. To gain competitive advantage Sustainable Organic Agriculture Sector Sectoral Strategies and Applications". (In Turkish).

[12] Arriaga, H. Núñez-Zofio, M.,. Larregla, S , and Merino, P., 2011, "Gaseous emissions from soil biodisinfestation by animal manure on a greenhouse pepper crop". *Crop Protection* 30: 412-419.

[13] Nolan, T., Troy, S. M., Healy, M. G., Kwapinski, W., Leahy, J. J., and Lawlor, P. G. 2011. "Characterization of compost produced from separated pig manure and a variety of bulking agents at low initial C/N ratios". *Bioresource Technology* 102(2011): 7131-7138.

[14] Sullivan, P. "Overview of Cover Crops and Green Manures" 2003. http://attra.ncat.org/attra-pub/covercrop.html. (accesse d: 27.01.2013).

[15] Urzua, H., Urzua, J. M., and Pizarro, R. 2001, "Pre-selection of Rhizobium leguminosarum cv. Viceae strains in forage vetch for use as green manure". *Ciencia-e-Investigacion-Agr aria* 28(1): 3-6.

[16] İnal, İ., Kuşvuran, A., Tansı, V., and Sağlamtimur, T., 2005. Tigem. (accessed::26.04.2005) www.tigem.gov.tr/guncel/ munavebe.asp-110k

[17] Olesen, J. E., Askegaard, M., and. Rasmussen, I. A., 2009. "Vinter creal yield as affecd by animal manure and green manure in organic arable farming". *European Journal of Agronomy* 30: 119-128

[18] Thorup-Kristensen, K., Magid, J., and Jensen, L. S., 2003. "Catch crops and green manures as biological tools in nitrogen management in temperate zones". *Advances in Agronomy* 79: 227-302.

[19] Muller, J C., Denys, D, Morle, G., and Mariotti, A., 1989. "Influence of catch crops on mineral nitrogen leaching and its subsequent plant use". Management Systems to Reduce Impact of Nitrates.

[20] Cavigelli, M. A. and Theien, S .J. 2004. "Phosphorus bioavailability following incorporation of green manure crop". 2004. *Soil Science Society of America Journal* 67: 1186-1194.

[21] Lehn-Reiser, M., Munch, J.C. , Chapot, J. Y., Ottow, J. C., 1990. "Field measured denitrification from a calcareous inceptisol after green manuring". *Mitteilungen-der-Deutsche n-Bodenkundlichen-Gesellschaft* 60: 233-238.

[22] Thonnissen, C., Midmore, D. J., Ladha, J.K., Holmer, R.J., and Schmidhalter, U. 2000. "Tomato crop response to short-duration legume green manures in tropical vegetable systems". *Agronomy Journal* 92: 245-253.

[23] Sorensen, J N. and Thorup-Kristensen, K., 2005. "An organic and environmentally friendly growing system for greenhouse tomatoes" http://orgprints.org/4624/ (accessed: 7.4.2005).

[24] Karaçancı, Aand Tüzel,. Y., 2006. Karaçancı A, Tüzel Y (2006) Effects of some organic fertilizers on yield and fruit quality of organic cucumbers grown in greenhouses.In: Third National Organic Agriculture Symposium, 1–4 November 2006, Yalova, pp. 297–307 (in Turkish).

[25] Vural, H., Eşiyok, D., and Duman, İ., 2000 Cultural Vegetables. Ege University Publications. 166. ISBN: 975-97 190-0-2 (In Turkish).

[26] Pearson, D., 1970. "The Chemical Analysis of Foods (6th

ed.)". Chemical Publishing Co. Inc., New York, USA.

[27] Fresenius, W., Quentin, K. E., and Schneider, W., 1998. "Water Analysis. A Practical Quide to Physicochemical, Chemical and Microbiological Water Examination and Quality Assurance". Springer-Verlag,

[28] Allen, R. G., Pereira, L. S., Raes, D., Smith, M., 1998. "Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements". FAO Irrigation and Drainage Paper: 56, Rome.

[29] Bremner, J. M., 1965. "Total nitrogen". Editor C.A. Black, Methods of Soil Analysis Part 2. *America Society of Agronomy* Inc. Publisher, Madison, Wisconsin, U.S.A. pp. 1149-1178.

[30] Rauterberg, E. and Kremkus, F. 1951. "Bestimmung von gesamthumus und alkalilöslichen humusstoffen im boden. Z.f Planzenernaehrung,". Düngung und Bodenkunde. Verlag, Chemie GmbH. Weinheim.

[31] Aybak, H.Ç. 2002. " Growing Lettuce ". Hasad Yayıncılık. (In Turkish)

[32] Eroğul, D., 2002. "Comparison of the use of Zeolite and perlite in crisp head lettuce growing". Ege University, Izmir Turkey. (In Turkish).

[33] Yuri, J. E., Resende, G. M. Mota, J. H., Souza, R.J. , and Carvalho, J. G., 2006. "Iceberg lettuce production in function of doses and application time of zinc". *Ciênia e Agrotecnoloia* 30(4): 665-669.

[34] Valšíková, M, and Viteková, A., 2006. "The effect of Lignofert organic fertilizer on formation and quality of head lettuce yield". *Horticultural Science (Prague)* 33(3): 114-118.

[35] Polat, E., Demir, H., and Onus, A. N., 2008. "Comparison of some yield and quality criteria in organically and conventionally-grown lettuce". *African Journal of Biotechnology* 7 (9): 1235-1239.

[36] Açıkgöz, E., 1995. "Forage Crops", 2. Basım. Uludağ Üniversitesi Basım Evi, Bursa.(In Turkish)

[37] Sloan, D. R., Kidder, G., and Jacobs, R. D., 2003."Poultry Manure as a Fertilizer". PS1 IFAS Extension. University of Florida, p. 241.

[38] Singh, Y., Singh, B., Maskina, M.S. and Meelu, O. P., 1987. "Effect of organic manures, crop residues and green manure (*Sesbania aculeata*) on nitrogen and phosphorus transformations in a sandy loam at field capacity and under waterlogged conditions". *Biology and Fertility of Soils* 6(2): 183-187.

[39] Thorup-Kristensen, K., 1999. "Root growth and soil nitrogen depletion by onion, lettuce, early cabbage and carrot. International Conference on Environmental Problems Associated with Nitrogen Fertilisation of Field Grown Vegetable Crops". *Acta Horticulturae* 563: 201-206.

[40] Eskici, Y., 2004. "Organic Waste, Microbiology and Soil". 2004. http://www.bugday.org/article.php?ID=29 (accessed: 3.4.2007). (In Turkish)

[41] Thorup-Kristensen, K., 1993. "Effect of nitrogen catch crops on the nitrogen nutrition of a succeding crop, I: Effects through mineralization and pre-emptive competition". *Acta Agricultura Scandinavica, Section B, Soil and Plant Science* 43: 74-81.

[42] Thorup-Kristensen, K., 1994. "Effect of nitrogen catch crop species on the nitrogen nutrition of a succeding crops". *Fertilizer Research* 37: 231-239. 649.