Role of different manure source and level on quantitative and qualitative characteristics of cabbage and spinach yield

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Abstract:

A field experiment was set up during the winter seasons of 2011-2014 and 2012-2013 to compare recommended chemical fertilizer (RCF) and three sources of composted manure on yield quantity and quality of cabbage (Brassica oleracea var. capitata, Copenhagen market cultivar) and spinach (Spinacea oleracea, local cultivar). Treatments included recommended chemical fertilizer (RCF) (T_1), sheep manure and cow manure at levels of 5,10 and 15% v/v of soil size (T_2, T_3, T_4, T_5, T_6 and T_7 respectively), and chicken manure at levels of 4,8 and (12%v/v of soil size (T_8, T_9, T_10 respectively) in addition to non-fertilized plants T_0. Organic manures were soil incorporated ten days before cabbage transplanting or spinach seed sowing, while RCF was consisted of 400 kg.ha^{-1} of Diammonium phosphate (DAP)+ 60kg.ha^{-1} of urea for each crop, DAP was applied side dressing two weeks after transplanting of cabbage or when seed germination was accomplished of spinach. Urea applied one month after DAP application. Treatments were arranged in Randomized Complete Block Design (RCBD) with three replicates. Results could be summarized as follows:

chicken manure at 12% v/v level (T_0) produced the greatest cabbage head weight in both seasons (926.4, 1981.5g, respectively). Highest total yield in
the first season was obtained from T10 (38.60 ton ha\(^{-1}\)), while in the second season T9 produced the highest yield (76.65 ton ha\(^{-1}\)). Both chemically and organically fertilized plant had high content of NO\(_3\) as compared to non-fertilized plants, but the level is still below of the harmful level to human health. The highest content of vitamin C was noticed in T7 and T6 (43.93 and 42.95 mg 100g\(^{-1}\) FWT) in first season, while in second season the highest content of vitamin C found in T10 treatment (39.74 mg 100g\(^{-1}\) FWT). The highest oxalic acid content was found in T5 and T6 in the two seasons which represent cow manure treatments. The highest spinach yield was obtained from high levels of organic manure treatment regardless of the source, where the highest in T9 (2.94 and 3.04 kg m\(^{-2}\)) as compared to RCE treatment (T1) (1.11 and 1.53 kg m\(^{-2}\)) for the two seasons, respectively. Nitrates content of spinach leaves was found to be the highest in T6 in the first season and RCF and T5 in the second season. Vitamin C content was the highest in T9 in first season and T3 in second season. Oxalic acid showed no clear trend where in first season, the highest in T3 while in second season the highest was in T9.

Key words: Manure, cabbage (Brassica oleracea) var. capitata, spinach (Spinacea oleracea) L.

* Part of Ph.D dissertation of the first Author
Cabbage (Brassica oleracea var. capitata L.) is among the most important dietary vegetables consumed in Iraq owing to their availability in local markets, cheapness, and consumer preference, and can be used as fresh (salad), cooked vegetable, and preparation of processed products. According to FAO (19), cabbage occupied 2,359,103 hectare (ha) produced 68,584,199 ton globally, whereas in Iraq the land area is 1,321 ha and produced 18,334 ton in 2011.

Spinach (Spinacia oleracea L.) is one of the most important vegetable crops grown for its leaves, and belong to the family Amaranthaceae. It is an annual plant that grows quickly and has the ability to survive winter temperature in temperate regions (6). It is very versatile since it is commonly used as salad, cooked vegetable, or as a component of many other cooked meat and vegetable dishes. The area occupied by spinach in the world...
experimental plot giving 9.6 m² area (this is for cabbage). For spinach, after soil have been plowed, a plots of 4m² (1x4) were prepared to represent experimental unit. Cabbage (Copenhagen market cultivar) seeds were sown on 1st August, 2011 and 25th July, 2012 while spinach (local cultivar) seeds were sown on 5th October, 2011 and 1st October, 2012. Cabbage transplants at 4 true leaves stage were pricked out 55 days after seed sowing in both seasons. Organic manure was collected from local sources on 15th May for both seasons composted for four months and every 2 weeks were mixed up for the uniformity of the moister and ventilation. Ten days before transplants of cabbage or spinach seed sowing were incorporated to the soil according to treatment levels. Table (2) shows the chemical analysis of each manure. Randomized Complete Block Design (R.C.B.D) was adopted in both experiments for each crop. The block consisted of eleven experimental units and treatments organically grown crops are believed to be healthier and to contain more minerals and vitamins than that of the conventional counterpart (33; 34).

The aim of current study was to evaluate the effect of three sources of animal manures at different levels on yield quantity and quality of two leafy vegetables (Cabbage and Spinach) under organic and conventional agriculture in Sulaimani provenance, north of Iraq.

Materials and Methods

A field experiment was conducted for two successive winter seasons of 2011-2012 and 2012-2013 at Bakrajo research field, Horticulture Department, Faculty of Agricultural Sciences, University of Sulaimani, Kurdistan region, Iraq. Soil samples (0-30 cm) were analyzed and some of physical and chemical properties shown in Table (1). Soil was plowed twice across each other and farrows were at length of 4 m and 0.8 m apart where three farrows in each
were formed in $T_0$ and $T_1$ in the first season, probably because of the very cold weathers during December, January and February and lower availability of nutrients (particularly N) during the season. Citak and Sonmez (17) found a positive relationship between chicken manure and cabbage yield and no head could form if there is N shortage. On the other hand, results showed that organically fertilized plants formed heads, which might be attributed to successive decomposition of organic material and release a beneficial organic matters (humus, humic acid and fulvic acid) (22). Humus complexes affected soil physical properties and the dark color absorb heat energy from the sun, thereby improving soil temperature for plant root growth and microbial activity (9). Chicken fertilizer at 8% (T_9) was not significantly differ from $T_{10}$ in head weight in both seasons which mean that this treatment could be use economically than $T_{10}$. The highest head weight produced by chicken fertilizer could be due to were randomly arranged. Treatments included control (without fertilizer, $T_0$), recommended as chemical fertilizer for each crop (RCF), ($T_1$) according to Matlobet al., (26), 400 kg ha$^{-1}$ of Diammonium phosphate + 60 kg urea .ha$^{-1}$. Sheep manure at 5,10 and 15% ($T_2,T_3,T_4$), cow manure at 5,10 and 15% ($T_5,T_6,T_7$), and chicken manure at 4,8 and 12% of soil volume ($T_8,T_9,T_{10}$). Experiments were concluded 180 and 160 days after transplanting for the two seasons for cabbage, while for spinach, final mowing was 120 and 110 days after seed sowing for the two seasons, receptively.

Results and Discussion

1 – Cabbage

Head weight was significantly affected by organic fertilizers where the greatest head weight was observed in $T_{10}$ in both seasons (926.4 and 1981.5 g, respectively) while the lowest was found in $T_0$ (1492.1g) in the second season (Table3). No heads
obtained from T₀ (8% chicken manure), whereas the lowest yield formed in T₂ in the first season (5% sheep manure) and T₀ (not fertilized plants) in second season (13.08 and 47.83 ton ha⁻¹, respectively). The highest cabbage yield obtained from organic fertilizers might be attributed to that manures provide as source of all necessary macro and micronutrient in available form in addition to the improving of physical and biological properties of the soil (13,1). The highest production of cabbage found in treatments received 8 and 12% of chicken manure and this may be due to the slow release of nutrients during growth stages in particular head formation stage in addition to higher nitrogen content and optimum C:N ratio (Table 2), while inorganic fertilizers provide nutrients to the growing plants at early stages (5). The highest concentration of N and P in chicken manure and the lowest C/N ratio may increase the rate of decomposition of manure that leading to higher vegetative the high N content and lower C:N ratio (Table 2). The mean head weight produced in this study was higher than that reported in other studies and this partly attributed to varietal response to favorable environments (21).

Results presented in (Table 3) showed significant differences in head diameter due to the source of organic fertilizer. The greatest diameter found in T₁₀ (13.5 cm) in the first season, while in second season there were no significant differences in head diameter, however, the heads in T₀ were lose although the diameter is similar to other treatments. Similar results of the positive effect of chicken manure on cabbage head diameter was reported (17).

Table (4) shows that organic fertilizers affected the total yield in both seasons significantly. In the first season the highest yield (38.60 ton ha⁻¹) was obtained from T₁₀ (12% chicken manure) while in second season the highest yield (75.32 ton ha⁻¹) was
accumulated as nitrate and stored in green leafy part of the plant (14). Nitrate accumulation in leaves increase due to the application of chemical fertilizer. Nitrogen amount could also be attributed to the increased rate of nitrogen absorption than assimilation within the plant. Howladar, et al. (20) also found that bio-nitrogen fertilizer resulted in production of broccoli plant with lower content of NO$_3$ for human healthy nutrition than chemical fertilizer.

Vitamin C of cabbage head was significantly affected by fertilizer treatment, in first season. T$_7$ and T$_8$ had the highest content (43.93 and 42.95 mg.100g$^{-1}$ FWT respectively) while the lowest in T$_3$ (35.47 mg 100g$^{-1}$ FWT) (Table6). In second season, the highest content of vitamin C was found in T$_{10}$ (12% chicken manure), while the lowest was in T$_1$ (35.41 mg.100g$^{-1}$ FWT). These results may be due to the fact that increased growth and higher accumulation of carbohydrates in organically grown cabbage growth and yield (29). Mbatha (27) similarly found that chicken manure produced better yield and quality of cabbage heads. Results showed in Table(5) indicates that in first season, the highest leaf contents of NO$_3$ in folded leaves (head) was noticed from T$_9$, with (770.80 mg.kg$^{-1}$) followed by treatment T$_8$ with (756.30 mg.kg$^{-1}$) while, the lowest was obtained from T$_3$ with (469.07 mg.kg$^{-1}$). In second season the highest NO$_3$ content found in plants of T$_2$ treatment (sheep manure at 5%) with (763.20 mg.kg$^{-1}$) which is statically not significantly different with the most of other organic or chemical fertilized plants. These results may indicate that both chemical and organic fertilizers may increase NO$_3$ in plants, however, increased NO$_3$ in organic manure treated plants may be due to the higher release of NH$_4$-N to the soil where great amount of it biologically oxidized to NO$_3$ and taken up by plants (4). Higher amount of nitrogen chemical fertilizer increase protein production and the excess is
in T₀ plants (7.13 leaf.plant⁻¹). In second season, T₁₀ produced the highest number of leaves (15.04 leaf.plant⁻¹), while (T₀) had the lowest leaf number (10.03 leaf.plant⁻¹). The high number of leaves produced by chicken fertilizer application could be due to the high content of N and P which play a vital role in cell division and elongation (10).

Leaf area data presented in Table(8) shows that T₁₀ had the greatest leaf area in both seasons (1609.56 and 1456.85 cm². Plant⁻¹, respectively), while the lowest was in (T₀) (181.44 cm². plant⁻¹) in first season, and T₁ and T₀ in second season (513.15 and 561.22 cm². plant⁻¹, respectively). Greater leaf area in spinach is one of the important quality traits, so increased leaf area economically effective. Increased spinach leaf area of chicken fertilizer at high rates (T₉ and T₁₀) may be due to high availability of N, P and K in this fertilizer (Table,2), in addition to the improved soil physical, chemical and biological character(2). Application of induced the synthesis of ascorbic acid (vitamin C)(34). Many researchers found similar positive effect of organic fertilizers on the amount of vitamin C in cabbage (14, 17, 23).

Regarding oxalic acid, Table(7) illustrate that in first season the highest content of cabbage head oxalic acid found in T₅ (701.77 mg.100g⁻¹FWT). In second season, T₆ and T₅ had the highest content of oxalic acid (747.54 and 714.42 mg.100g⁻¹FWT, respectively). Increased oxalic acid concentration by using organic fertilizers may be attributed to high rate of Ca uptake that released from the manure decomposition as counterpart to prevent Ca toxicity (2).

2- Spinach:

Data in Table(8) showed that organic fertilization increased the number of leaves per plant during both seasons. In first season, chicken manure at 8% (T₉) had the highest number of leaves (11.20 leaf .plant⁻¹) whereas, the lowest leaf number in was found
Plant high yield of chicken fertilizer application may be due to high content of N,P and K (Table 2). Similar results were reported by Xu et al., (35) when leafy vegetables yield was greater than that of synthetic fertilizer. Sajirani et al., (32) also found greater spinach yield with organic fertilizer application.

Nitrates accumulation in spinach leaves is significantly affected by fertilizer source (Table, 9). In first season the highest nitate content was (927.04mg.kg^{-1} ondry weight basis, Dwt ) in T_{6} while, the lowest was(574.25mgkg^{-1} DWT) in T_{10}(Table 10). In second season the highest content of nitrates (1152.16mgkg^{-1} DWT) was recorded in T_{1} and T_{5} whereas, the Lowest (622.59mg.kg^{-1}DWT) in T_{10}. The lowest leaf content of NO\textsubscript{3} of high level of organic fertilizer application (T_{10} ) may be related to the higher soil biological activity, larger leaf area that permits higher demands and faster conversion process of nitrates to amino acids and proteins , and organic fertilizer may affect plant growth as a source of growth promoters, auxins , vitamins and amino acid which positively affect vegetative growth (28). Data in Table(9) reveal that application of organic fertilizers regardless the source, produced higher yield when used at higher levels (T_{3} , T_{4},T_{6} ,T_{7} ,T_{9}andT_{10} ) as compared to T_{1} . However, the highest yield (2.94 and 3.04 kg .m^{-2}) obtained from in both seasons. Minimum yield was found in control treatment (T_{0}) in first season (0.30kg.m^{-2}) andT_{2} in the second season (1.35kg.m^{-2}). This could be due to the fact that application of manure improves soil properties activity , water holding capacity , plant growth and yield (1;8;13;11). Ouda and Mahaden(30) refered that organic manure increased broccoli yield due to increased soil organic matter content , rate of decomposition, generation of CO\textsubscript{2} , and improving soil structure conditions,these encouraging better root and whole plant growth.
vitamin C content of organically grown spinach may support the C / N balance theory of an increase growth and biomass production in RCF grown plants because of high nitrogen availability that may have a diluting effect on the concentration of ascorbic acid (24). Similar results were obtained by Citak and Sonmez (15) where vitamin C of organically grown spinach was higher than that grown conventionally.

Table(12) revealed that the highest oxalic acid in first season (1379.18 mg 100g⁻¹FWT) was recorded from T₃ while the lowest (1037.55 mg 100FWT) was resulted T₀. However , in second season the highest oxalic acid (1505.71 mg .100g FWT) was obtained from T₅ while the lowest (1095.23mg. 100g⁻¹ FWT) was recorded in T₀. Oxalates production increased with higher concentration of nitrates to limit soluble organic anions contents produced during NO₃ reduction (18). Xu et al ., (35) reported that oxalate accumulated in some
Table 1: Some physical and chemical properties of the experiment soil during the two seasons of 2012 and 2013.

<table>
<thead>
<tr>
<th>Soil properties</th>
<th>First season 2011-2012</th>
<th>Second season 2012-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand (g.kg(^{-1}))</td>
<td>48.9</td>
<td>48.6</td>
</tr>
<tr>
<td>Silt (g.kg(^{-1}))</td>
<td>449.4</td>
<td>450</td>
</tr>
<tr>
<td>Clay (g.kg(^{-1}))</td>
<td>501.7</td>
<td>501.4</td>
</tr>
<tr>
<td>Soil texture</td>
<td>Silty Clay</td>
<td>Silty Clay</td>
</tr>
<tr>
<td>E.C (dSm(^{-1}))</td>
<td>0.33</td>
<td>0.4</td>
</tr>
<tr>
<td>Ph</td>
<td>7.11</td>
<td>7.51</td>
</tr>
<tr>
<td>O.M (g.kg(^{-1}))</td>
<td>20.8</td>
<td>29.5</td>
</tr>
<tr>
<td>CaCO(_3) (g.kg(^{-1}))</td>
<td>245</td>
<td>251</td>
</tr>
<tr>
<td>Available Phosphate (mg.Kg(^{-1}) soil)</td>
<td>6.8</td>
<td>6.12</td>
</tr>
<tr>
<td>Total N (ppm)</td>
<td>0.1</td>
<td>0.12</td>
</tr>
<tr>
<td>K(^+) (meq.l(^{-1}))</td>
<td>0.25</td>
<td>0.21</td>
</tr>
<tr>
<td>Na(^+) (meq.l(^{-1}))</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Ca(^{2+}) (meq.l(^{-1}))</td>
<td>2.75</td>
<td>2.21</td>
</tr>
<tr>
<td>Mg(^{2+}) (meq.l(^{-1}))</td>
<td>1.98</td>
<td>1.7</td>
</tr>
<tr>
<td>CO(_3^{2-}) (meq.l(^{-1}))</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>HCO(_3^{2-}) (meq.l(^{-1}))</td>
<td>8.59</td>
<td>8.11</td>
</tr>
<tr>
<td>Cl(^-) (meq.l(^{-1}))</td>
<td>2.86</td>
<td>2.72</td>
</tr>
</tbody>
</table>
Table 2: The chemical analysis of the composted manure used in this experiment.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Unit</th>
<th>Sheep manure</th>
<th>Cow manure</th>
<th>Chicken manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic carbon</td>
<td>(g.Kg⁻¹)</td>
<td>330</td>
<td>309</td>
<td>270</td>
</tr>
<tr>
<td>Total N</td>
<td>(g.Kg⁻¹)</td>
<td>23</td>
<td>21</td>
<td>21.2</td>
</tr>
<tr>
<td>C:N ratio</td>
<td></td>
<td>14.34</td>
<td>14.71</td>
<td>12.73</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>(g.Kg⁻¹)</td>
<td>10.1</td>
<td>8.5</td>
<td>10.6</td>
</tr>
<tr>
<td>Total potassium</td>
<td>(g.Kg⁻¹)</td>
<td>15.5</td>
<td>19.1</td>
<td>19.9</td>
</tr>
</tbody>
</table>

found between ascorbic acid (vitamin C) and oxalate content in spinach plants.

It could be concluded from this experiment that cabbage and spinach yield quantity and quality could be increased by manure application regardless the source. Soil analysis performed at Agriculture Research Center in Bakrajo vegetable crops as a result of nitrate nutrition.

In this investigation, results showed that organically fertilized spinach plants had higher vitamin C content (table 11) and higher oxalic acid (T₉ in second season) as compared to RCF treated plants. These results in agreement with the conclusion of okhet al., (24) that a positive correlation was
Table 3: Effect of fertilizer treatments on head weight and head diameter in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Head weight (g)</th>
<th>Head diameter (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td><strong>T₀ (Control)</strong></td>
<td>-†</td>
<td>1492.11</td>
</tr>
<tr>
<td><strong>T₁ Chemical fertilizer</strong></td>
<td>-</td>
<td>1748.93</td>
</tr>
<tr>
<td><strong>T₂ Sheep 5%</strong></td>
<td>323.66 ‡‡</td>
<td>1971.47</td>
</tr>
<tr>
<td><strong>T₃ Sheep 10%</strong></td>
<td>438.56</td>
<td>1713.29</td>
</tr>
<tr>
<td><strong>T₄ Sheep 15%</strong></td>
<td>415.83</td>
<td>1745.00</td>
</tr>
<tr>
<td><strong>T₅ Cow 5%</strong></td>
<td>411.19</td>
<td>1576.56</td>
</tr>
<tr>
<td><strong>T₆ Cow 10%</strong></td>
<td>331.20</td>
<td>1581.01</td>
</tr>
<tr>
<td><strong>T₇ Cow 15%</strong></td>
<td>507.88</td>
<td>1548.53</td>
</tr>
<tr>
<td><strong>T₈ Chicken 4%</strong></td>
<td>711.35</td>
<td>1810.19</td>
</tr>
<tr>
<td><strong>T₉ Chicken 8%</strong></td>
<td>787.02</td>
<td>1896.60</td>
</tr>
<tr>
<td><strong>T₁₀ Chicken 12%</strong></td>
<td>926.37</td>
<td>1981.45</td>
</tr>
<tr>
<td><strong>LSD₀.₀₅</strong></td>
<td>167.12</td>
<td>434.54</td>
</tr>
</tbody>
</table>

† Heads were not formed in T₀ and T₁ in first season

‡‡ Means with the same letters are not different significantly at L.S.D. test (P ≤ 0.05).
Table 4: Effect of fertilizer treatments on cabbage total yield in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total yield (ton ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>T(_0) (Control)</td>
<td>-(^†)</td>
</tr>
<tr>
<td>T(_1) Chemical fertilizer</td>
<td>-</td>
</tr>
<tr>
<td>T(_2) Sheep 5%</td>
<td>13.08(^††)</td>
</tr>
<tr>
<td>T(_3) Sheep 10%</td>
<td>16.76</td>
</tr>
<tr>
<td>T(_4) Sheep 15%</td>
<td>17.33</td>
</tr>
<tr>
<td>T(_5) Cow 5%</td>
<td>14.04</td>
</tr>
<tr>
<td>T(_6) Cow 10%</td>
<td>13.80</td>
</tr>
<tr>
<td>T(_7) Cow 15%</td>
<td>20.45</td>
</tr>
<tr>
<td>T(_8) Chicken 4%</td>
<td>28.79</td>
</tr>
<tr>
<td>T(_9) Chicken 8%</td>
<td>32.79</td>
</tr>
<tr>
<td>T(_{10}) Chicken 12%</td>
<td>38.60</td>
</tr>
<tr>
<td>LSD(_{0.05})</td>
<td>6.10</td>
</tr>
</tbody>
</table>

\(^†\) Heads were not formed in T\(_0\) and T\(_1\) in first season

\(^††\) Means with the same letters are not different significantly at L.S.D. test (P\(\leq\) 0.05).
Table 5: Effect of fertilizer treatments on cabbage nitrate content of folded leaves in 2012 and 2013 season.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Nitrate (mg.kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>T₀ (Control)</td>
<td>- †</td>
</tr>
<tr>
<td>T₁ Chemical fertilizer</td>
<td>-</td>
</tr>
<tr>
<td>T₂ Sheep 5%</td>
<td>523.10 ‡‡</td>
</tr>
<tr>
<td>T₃ Sheep 10%</td>
<td>469.07</td>
</tr>
<tr>
<td>T₄ Sheep 15%</td>
<td>571.67</td>
</tr>
<tr>
<td>T₅ Cow 5%</td>
<td>644.97</td>
</tr>
<tr>
<td>T₆ Cow 10%</td>
<td>560.70</td>
</tr>
<tr>
<td>T₇ Cow 15%</td>
<td>644.87</td>
</tr>
<tr>
<td>T₈ Chicken 4%</td>
<td>756.30</td>
</tr>
<tr>
<td>T₉ Chicken 8%</td>
<td>770.80</td>
</tr>
<tr>
<td>T₁₀ Chicken 12%</td>
<td>524.33</td>
</tr>
<tr>
<td>LSD₀.₀⁵</td>
<td>79.11</td>
</tr>
</tbody>
</table>

† Heads were not formed in T₀ and T₁ in first season.

‡‡ Means with the same letters are not different significantly at L.S.D. test (P≤ 0.05).
Table 6: Effect of fertilizer treatments on cabbage vitamin C content in 2012 and 2013

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Vitamin C (mg.100g(^{-1})Fwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>(T_0) (Control)</td>
<td>- (^{†})</td>
</tr>
<tr>
<td>(T_1) Chemical fertilizer</td>
<td>-</td>
</tr>
<tr>
<td>(T_2) Sheep 5%</td>
<td>40.07(^{‡‡})</td>
</tr>
<tr>
<td>(T_3) Sheep 10%</td>
<td>35.47</td>
</tr>
<tr>
<td>(T_4) Sheep 15%</td>
<td>38.28</td>
</tr>
<tr>
<td>(T_5) Cow 5%</td>
<td>41.51</td>
</tr>
<tr>
<td>(T_6) Cow 10%</td>
<td>38.14</td>
</tr>
<tr>
<td>(T_7) Cow 15%</td>
<td>42.95</td>
</tr>
<tr>
<td>(T_8) Chicken 4%</td>
<td>43.93</td>
</tr>
<tr>
<td>(T_9) Chicken 8%</td>
<td>39.19</td>
</tr>
<tr>
<td>(T_{10}) Chicken 12%</td>
<td>40.39</td>
</tr>
<tr>
<td>LSD(_{0.05})</td>
<td>7.04</td>
</tr>
</tbody>
</table>

\(^{†}\) Heads were not formed in \(T_0\) and \(T_1\) in first season.

\(^{‡‡}\) Means with the same letters are not different significantly at L.S.D. test.
Table (7): Effect of fertilizer treatments on cabbage oxalic acid content in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Oxalic acid (mg.100g(^{-1})Fwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>T(_0) (Control)</td>
<td>-†</td>
</tr>
<tr>
<td>T(_1) Chemical fertilizer</td>
<td>-</td>
</tr>
<tr>
<td>T(_2) Sheep 5%</td>
<td>583.26 ‡‡</td>
</tr>
<tr>
<td>T(_3) Sheep 10%</td>
<td>659.18</td>
</tr>
<tr>
<td>T(_4) Sheep 15%</td>
<td>656.46</td>
</tr>
<tr>
<td>T(_5) Cow 5%</td>
<td>701.77</td>
</tr>
<tr>
<td>T(_6) Cow 10%</td>
<td>557.96</td>
</tr>
<tr>
<td>T(_7) Cow 15%</td>
<td>595.92</td>
</tr>
<tr>
<td>T(_8) Chicken 4%</td>
<td>613.19</td>
</tr>
<tr>
<td>T(_9) Chicken 8%</td>
<td>621.22</td>
</tr>
<tr>
<td>T(_{10}) Chicken 12%</td>
<td>583.26</td>
</tr>
<tr>
<td>LSD0.05</td>
<td>99.54</td>
</tr>
</tbody>
</table>

†Heads were not formed in T\(_0\) and T\(_1\) in first season.

‡‡Means with the same letters are not different significantly at L.S.D. test (P≤ 0.05).
Table 8: Effect of fertilizer treatments on spinach leaf number and leaf area in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Leaf number, plant-1</th>
<th>Leaf area (cm².plant-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>T0 (Control)</td>
<td>7.13</td>
<td>10.03</td>
</tr>
<tr>
<td>T1 Chemical fertilizer</td>
<td>7.34</td>
<td>10.35</td>
</tr>
<tr>
<td>T2 Sheep 5%</td>
<td>9.69</td>
<td>10.28</td>
</tr>
<tr>
<td>T3 Sheep 10%</td>
<td>10.04</td>
<td>11.60</td>
</tr>
<tr>
<td>T4 Sheep 15%</td>
<td>10.66</td>
<td>13.23</td>
</tr>
<tr>
<td>T5 Cow 5%</td>
<td>9.37</td>
<td>11.77</td>
</tr>
<tr>
<td>T6 Cow 10%</td>
<td>9.33</td>
<td>12.90</td>
</tr>
<tr>
<td>T7 Cow 15%</td>
<td>9.50</td>
<td>13.25</td>
</tr>
<tr>
<td>T8 Chicken 4%</td>
<td>9.43</td>
<td>10.99</td>
</tr>
<tr>
<td>T9 Chicken 8%</td>
<td>11.20</td>
<td>12.71</td>
</tr>
<tr>
<td>T10 Chicken 12%</td>
<td>10.43</td>
<td>15.04</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>1.16</td>
<td>1.82</td>
</tr>
</tbody>
</table>

† Means with the same letters are not different significantly at L.S.D. test (P ≤ 0.05).
### Table 9: Effect of fertilizer treatments on spinach yield in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total yield (kg.m$^{-2}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>$T_0$ (Control)</td>
<td>0.30 †</td>
</tr>
<tr>
<td>$T_1$ Chemical fertilizer</td>
<td>1.11</td>
</tr>
<tr>
<td>$T_2$ Sheep 5%</td>
<td>1.31</td>
</tr>
<tr>
<td>$T_3$ Sheep 10%</td>
<td>1.53</td>
</tr>
<tr>
<td>$T_4$ Sheep 15%</td>
<td>2.10</td>
</tr>
<tr>
<td>$T_5$ Cow 5%</td>
<td>1.96</td>
</tr>
<tr>
<td>$T_6$ Cow 10%</td>
<td>1.88</td>
</tr>
<tr>
<td>$T_7$ Cow 15%</td>
<td>1.85</td>
</tr>
<tr>
<td>$T_8$ Chicken 4%</td>
<td>1.75</td>
</tr>
<tr>
<td>$T_9$ Chicken 8%</td>
<td>2.94</td>
</tr>
<tr>
<td>$T_{10}$ Chicken 12%</td>
<td>2.51</td>
</tr>
<tr>
<td>LSD$_{0.05}$</td>
<td>0.39</td>
</tr>
</tbody>
</table>

†Means with the same letters are not different significantly at L.S.D. test (P≤ 0.05).
Table 10: Effect of fertilizer treatments on spinach nitrate content in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Nitrate (mg.kg⁻¹Dwt)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>T₀ (Control)</td>
<td>692.81 †</td>
<td>911.15</td>
<td></td>
</tr>
<tr>
<td>T₁ Chemical fertilizer</td>
<td>809.37</td>
<td>1152.16</td>
<td></td>
</tr>
<tr>
<td>T₂ Sheep 5%</td>
<td>852.77</td>
<td>1029.22</td>
<td></td>
</tr>
<tr>
<td>T₃ Sheep 10%</td>
<td>638.12</td>
<td>1085.50</td>
<td></td>
</tr>
<tr>
<td>T₄ Sheep 15%</td>
<td>907.47</td>
<td>1069.10</td>
<td></td>
</tr>
<tr>
<td>T₅ Cow 5%</td>
<td>748.18</td>
<td>1152.16</td>
<td></td>
</tr>
<tr>
<td>T₆ Cow 10%</td>
<td>927.04</td>
<td>894.75</td>
<td></td>
</tr>
<tr>
<td>T₇ Cow 15%</td>
<td>638.12</td>
<td>902.95</td>
<td></td>
</tr>
<tr>
<td>T₈ Chicken 4%</td>
<td>835.32</td>
<td>981.66</td>
<td></td>
</tr>
<tr>
<td>T₉ Chicken 8%</td>
<td>844.49</td>
<td>788.73</td>
<td></td>
</tr>
<tr>
<td>T₁₀ Chicken 12%</td>
<td>574.25</td>
<td>622.59</td>
<td></td>
</tr>
<tr>
<td>LSD₀.₀₅</td>
<td>203.47</td>
<td>201.70</td>
<td></td>
</tr>
</tbody>
</table>

†Means with the same letters are not different significantly at L.S.D. test (P≤ 0.05).
Table 11: Effect of fertilizer treatments on Spinach vitamin C content in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Vitamin C (mg.100g⁻¹Fwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>T₀ (Control)</td>
<td>24.09 †</td>
</tr>
<tr>
<td>T₁ Chemical fertilizer</td>
<td>30.61</td>
</tr>
<tr>
<td>T₂ Sheep 5%</td>
<td>25.84</td>
</tr>
<tr>
<td>T₃ Sheep 10%</td>
<td>33.32</td>
</tr>
<tr>
<td>T₄ Sheep 15%</td>
<td>35.42</td>
</tr>
<tr>
<td>T₅ Cow 5%</td>
<td>35.42</td>
</tr>
<tr>
<td>T₆ Cow 10%</td>
<td>31.56</td>
</tr>
<tr>
<td>T₇ Cow 15%</td>
<td>32.72</td>
</tr>
<tr>
<td>T₈ Chickeny 4%</td>
<td>39.91</td>
</tr>
<tr>
<td>T₉ Chicken 8%</td>
<td>41.42</td>
</tr>
<tr>
<td>T₁₀ Chicken 12%</td>
<td>39.70</td>
</tr>
<tr>
<td>LSD₀.₀₅</td>
<td>8.15</td>
</tr>
</tbody>
</table>

† Means with the same letters are not different significantly at L.S.D. test (P≤ 0.05).
Table 12: Effect of fertilizer treatments on oxalic acid content of spinach in 2012 and 2013.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Oxalic acid (mg.100g(^{-1})Fwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td>(T_0) (Control)</td>
<td>1202.04 (\dagger)</td>
</tr>
<tr>
<td>(T_1) Chemical fertilizer</td>
<td>1341.22</td>
</tr>
<tr>
<td>(T_2) Sheep 5%</td>
<td>1379.18</td>
</tr>
<tr>
<td>(T_3) Sheep 10%</td>
<td>1353.87</td>
</tr>
<tr>
<td>(T_4) Sheep 15%</td>
<td>1303.26</td>
</tr>
<tr>
<td>(T_5) Cow 5%</td>
<td>1303.26</td>
</tr>
<tr>
<td>(T_6) Cow 10%</td>
<td>1417.14</td>
</tr>
<tr>
<td>(T_7) Cow 15%</td>
<td>1277.95</td>
</tr>
<tr>
<td>(T_8) Chicken 4%</td>
<td>1290.61</td>
</tr>
<tr>
<td>(T_9) Chicken 8%</td>
<td>1037.55</td>
</tr>
<tr>
<td>(T_{10}) Chicken 12%</td>
<td>1075.51</td>
</tr>
<tr>
<td><em>LSD(_{0.05})</em></td>
<td>259.44</td>
</tr>
</tbody>
</table>

\(\dagger\) Means with the same letters are not different significantly at L.S.D. test (\(P \leq 0.05\)).
References


12-Citak, S. and Sonmez, S. 2010a. Effects of conventional and organic fertilization on spinach (Spinacea oleracea L.) growth, yield, vitamin C and nitrate concentration during two successive seasons. Scientia Horticulturae, 126 415–420


34-Worthington, V. 2001. Nutritional quality of organic versus conventional fruits, vegetables, and grains, J.

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المستخلص:

نفذت تجربة حقلية للموسم الشتوي 2011-2012 و2013 لمقارنة إضافة السماد الكيميائي المصري به من قبل مطلوب وأخرون (26) مع ثلاثية مصدر من الأسماك العضوية المخمرة في كمية ونوعية اللحاثة (Brassica oleracea var.capitata) وصنف كونهاج (Spinacea oleracea L.)، حاضرة في الصنف المحلي. تضمنت المعاملات السماد المحمي بش (RCF) (T1)، سداد الأغذية والأغذية بمستويات 5، 10 و 15% (حجم/حجم) تتمثل المعاملات على الترتيب T7،T6،T5،T4،T3،T2 حيث لم تشفف أية سرقة. خلفت مصادر السماد العضوية تقلل من كمية ونوعية الزراعة تجاه السماد T0،T9،T8 الداخلي (الفوسفات ثنائي الأمونيوم) (DAP) 1 كغم هكتار من السماد (RCF) الشامل من السباق في حمض السماد 400 كغم هكتار + 60 كغم هكتار من البيولا لكل محصول. أضيف سماد الـ DAP أسلف خط النباتات في أدنى DAP بعد أن تصل إلى انتهاء الزراعة. أضيفت البيولا بعد مرور شهر من إضافة الـ DAP ونفس الظروف. وزعت المعاملات حسب تصميم القطاعات الكاملة المعنيه RCBD مكررات. ويمكن إيجاز النتائج كالتالي:

سماد الدجاج الخضر باستخدام T10 (12%) ينتج أكبر وزن للمرؤوس في اللحاثة في كل المواسم (T10) (1981.5 غ) على الترتيب. أعلى إنتاجية في الموسم الأول كانت عند المعاملة 926.4 (T9) بينما في الموسم الثاني كانت عند المعاملة 65.65 طن هكتار. T7 38.60 طن هكتار. محتوى الرؤوس من النباتات (PO3) كان مرتفع في النباتات المسامة سواء بالسماد الكيميائي أو العضوية مقارنة بنباتات القبض لكن المحتوى لم يصل إلى المستوى المؤثر في صحة الإنسان. أعلى
مستوى من فيتامين C وجد في اللحاءة المسادة بالمعاملتين T8 وT7 (93.95 ملغم/100 غم وزن طري). أعلى تركيز لحامض الأوزكراليك وجد في المعاملات T5 في الموسم على الترتيب والتي تمت معاملات سمام الأبقار.

أعلى حاصل من السباع نتج من المعاملات بالأسامة العضوية وباعلى المستوى بغض النظر عن المصدر وأعلاها في المعاملة T9 للمؤسس (0.94 و 3.04 كغ/م²) مقارنة مع المعاملة السماد الكيميائي (RCF) T1 (1.11 و 1.53 كغ/م²) للمؤسس على الترتيب. أعلى محتوى من النترات في السباع وجدت في المعاملة T6 في الموسم الأول وT1 و T5 في الموسم الثاني. أعلى محتوى من فيتامين C وجد في المعاملة T6 في الموسم الأول و T3 في الموسم الثاني. لم يظهر حامض الأوزكراليك إنتاج معين حيث أعلى تركيز ظهر في T3 في الموسم الأول في حين كان في T9 في الموسم الثاني.

كلمات مفتاحية: أسامة عضوية مخمرة، لحاءة، سباع

* جزء من أطروحة دكتوراه للباحث الأول.