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# 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 $T_{10}$ (38.60 tonha$^{-1}$), while in the second season $T_9$ 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 $T_7$ and $T_8$(43.93 and 42.95 mg.100g$^{-1}$ FWT) in first season, while in second season the highest content of vitamin C found in $T_{10}$ treatment (39.74mg.100$^{-1}$gFWT). The highest oxalic acid content was found in $T_5$ and $T_6$ 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$T_9$ (2.94 and 3.04 kg.m$^{-2}$) as compared to RCE treatment($T_1$) (1.11and 1.53 kg.m$^{-2}$) for the two seasons, respectively. Nitrates content of spinach leaves was found tobe the highest in$T_6$ in the first season and RCF and $T_5$ in the second season. Vitamin C content was the highest in$T_9$ in first season and $T_3$ in second season. Oxalic acid showed no clear trend where in first season, the highest in$T_3$ while in second season the highest was in $T_9$.

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

* Part of Ph .D dissertation of the first Author

is about 867,728 ha and total yield 20,980,488 ton ,whereas , in Iraq the total area is 1,321 ha with totalyield of 11,177 ton in 2011(19) .

Care about the growing conditions of crops has often been taken into consideration by customers now days. This is probably because of some health problems arising from the consumption of the unhealthy food crops grown under intensive farming conditions such as excessive pesticides or chemical fertilizers. Therefore , growing food crops organically has gained popularity around the world (15). Organic farming is a production system which avoids or largely excludes the use of synthetically produced fertilizers, pesticides , growth regulators and livestock feed additives relying instead of crop rotations, crop residues, animal manures , legumes , green manures and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects , weeds and other pests (25) . Additionally ,

## Introduction:

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,while in Iraq the land area is 1,356 ha and produced 18334 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, acooked 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 $m^2$ area (this is for cabbage ). For spinach , after soil have been plowed , a plots of $4m^2$ (1x4) were prepared to represent experimental unit. Cabbage(Copenhagen marketcultivar ) 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 4true 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 (0-30cm) 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 4m and 0.8m 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 apositive 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). Chickenfertilizer 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 aschemicalfertilizer for each crop(RCF),($T_1$) according to Matlob*et al*.,(26),400kg.ha$^{-1}$ of Diammonum phosphate + 60kg 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$T_9$ (8% chicken manure), whereas the lowest yield formed in $T_2$ in the first season (5% sheep manure ) and $T_0$ (not fertilized plants) in second season (13.08 and 47.83ton.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 (Table2). 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 (Table3) showed significant differences in head diameter due to the source of organic fertilizer. The greatest diameter found in $T_{10}$ (13.5cm) in the first season ,while in second season there were no significant differences in head diameter,however, the heads in $T_0$ 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$T_{10}$ (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 the 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 42.95mg.100g$^{-1}$ FWT respectively) while the lowest in $T_3$ (35.47mg 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 $T_1$ (35.41mg.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 (770.80mg.kg$^{-1}$) followed by treatment $T_8$ with (756.30 mg.kg$^{-1}$) while, the lowest was obtained from $T_3$ with (469.07mg.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 $T_0$ plants (7.13leaf.plant$^{-1}$ ). In second season,$T_{10}$ produced the highest number of leaves (15.04leaf.plant$^{-1}$), while ($T_0$ ) had the lowest leaf number (10.03leaf.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 $T_{10}$ had the greatest leaf area in both seasons (1609.56 and 1456.85 cm$^2$. Plant$^{-1}$,respectively ), while the lowest was in ($T_0$ ) (181.44 cm$^2$.plant$^{-1}$ ) in first season, and $T_1$and $T_0$ in second season (513.15 and 561.22 cm$^2$ .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 chickenfertilizer at high rates ($T_9$ and $T_{10}$)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 $T_5$ (701.77mg.100g$^{-1}$FWT). In second season,$T_6$ and$T_5$ had the highest content of oxalic acid (747.54 and 714.42mg.l00g$^{-1}$ FWT, 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 preventCa 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% ($T_9$) 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 nitrate 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 $NO_3$ 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 ($T_3$ , $T_4$,$T_6$ ,$T_7$ ,$T_9$and$T_{10}$) 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$^{-2}$) and$T_2$ 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 $CO_2$ , 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 $100g^{-1}$FWT) was recorded from$T_3$ while the lowest (1037.55 mg .100FWT) was resulted $T_9$. However , in second season the highest oxalic acid (1505.71 mg .100g FWT) was obtained from $T_9$ while the lowest ( 1095.23mg. $100g^{-1}$ FWT) was recorded in $T_0$. Oxalates production increased with higher concentration of nitrates to limit soluble organic anions contents produced during $NO_3$ reduction (18). Xu *et al* ., (35) reported that oxalate accumulated in some gradual conversion of organic nitrogen of the fertilizer to the nitrates from that allows a synchronized manure with plant nutrients demands. Chemical fertilizer on the other hands, dissolve faster resulting in the highest level of nitrates taken up by plant beyond the ability of spinach plant to reduce it and assimilate proteins , accumulate as nitrates. Ramachandran *et al*.,(31) found similar results with lower nitrates in spinach plants grown organically. okh*et al* .,(24) also reported that spinach grown under organic system had lower nitrates than that grown conventionally.

Table(11) reveal that$T_9$ had the highest content of vitamin C (41.42 mg.100g $^{-1}$FWT) in first season. However in second season, $T_3$ had the highest vitamin C content which have no significant differences with $T_7$ ,$T_9$ and$T_{10}$ (36.08, 35.25 , 34.91 and 34.30 mg. $100g^{-1}$ FWT, respectively ). The lowest vitamin C content found in $T_0$ in both seasons (24.09 and 26.30 mg.100g FWT, respectively ). Higher

**Table 1: Some physical and chemical properties of the experiment soil during thetwo seasons of 2012 and 2013 .**

| Soil properties | First season 2011-2012 | Second season 2012-2013 |
|---|---|---|
| Sand ($g.kg^{-1}$) | 48.9 | 48.6 |
| Silt ($g.kg^{-1}$) | 449.4 | 450 |
| Clay ($g.kg^{-1}$) | 501.7 | 501.4 |
| Soil texture | Silty Clay | Silty Clay |
| E.C ($dSm^{-1}$) | 0.33 | 0.4 |
| Ph | 7.11 | 7.51 |
| O.M ($g.kg^{-1}$) | 20.8 | 29.5 |
| $CaCO_3$ ($g.kg^{-1}$) | 245 | 251 |
| Available Phosphate ($mg.Kg^{-1}$) soil | 6.8 | 6.12 |
| Total N (ppm) | 0.1 | 0.12 |
| $K^{+}$($meq.l^{-1}$) | 0.25 | 0.21 |
| $Na^{+}$($meq.l^{-1}$) | 0.9 | 1.0 |
| $Ca^{2+}$ ($meq.l^{-1}$) | 2.75 | 2.21 |
| $Mg^{2+}$ ($meq.l^{-1}$) | 1.98 | 1.7 |
| $CO3^{2-}$ ($meq.l^{-1}$) | 0.00 | 0.00 |
| $HCO_3^{2-}$ ($meq.l^{-1}$) | 8.59 | 8.11 |
| $Cl^{-}$ ( $meq.l^{-1}$) | 2.86 | 2.72 |

**Table 2: The chemical analysis of the composted manure used in this experiment.**

| Variables | Unit | Sheep manure | | Cow manure | | Chicken manure | |
|---|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Organic carbon | ($g.Kg^{-1}$) | 330 | 309 | 270 | 339 | 367 | 362 |
| Total N | ($g.Kg^{-1}$) | 23 | 21 | 21.2 | 22.5 | 30.2 | 30.5 |
| C:N ratio | | 14.34 | 14.71 | 12.73 | 15.06 | 12.15 | 12.27 |
| Total phosphorus | ($g.Kg^{-1}$) | 10.1 | 8.5 | 10.6 | 8.3 | 9.7 | 10.6 |
| Total potassium | ($g.Kg^{-1}$) | 15.5 | 19.1 | 19.9 | 16.1 | 19.7 | 23.8 |

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 ($T_9$ insecond season) as compared to RCF treated plants. These results in agreement with the conclusion of okh*et al*., (24) that apositive correlation was

**Table 3: Effect of fertilizer treatments on head weight and head diameter in 2012 and 2013.**

| Treatments | Head weight (g) | | Head diameter (cm) | |
|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 |
| $T_0$ (Control) | -† | 1492.11 | - | 19.12 |
| $T_1$Chemical fertilizer | - | 1748.93 | - | 19.24 |
| $T_2$ Sheep 5% | 323.66 †† | 1971.47 | 8.55 | 19.67 |
| $T_3$ Sheep 10% | 438.56 | 1713.29 | 9.53 | 18.48 |
| $T_4$ Sheep 15% | 415.83 | 1745.00 | 9.38 | 19.36 |
| $T_5$ Cow 5% | 411.19 | 1576.56 | 9.35 | 18.16 |
| $T_6$ Cow 10% | 331.20 | 1581.01 | 9.53 | 18.79 |
| $T_7$ Cow 15% | 507.88 | 1548.53 | 10.23 | 18.00 |
| $T_8$chicken 4% | 711.35 | 1810.19 | 11.52 | 18.94 |
| $T_9$ chicken 8% | 787.02 | 1896.60 | 11.91 | 19.99 |
| $T_{10}$ chicken 12% | 926.37 | 1981.45 | 13.48 | 18.82 |
| $LSD_{0.05}$ | 167.12 | 434.54 | 1.40 | N.S. |

† Heads were not formed in $T_0$ and $T_1$ infirst season

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

**Table 4: Effect of fertilizer treatments on cabbage total yield in 2012 and 2013.**

| Treatments | Total yield (ton $ha^{-1}$) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | -† | 47. 83 |
| $T_1$ Chemical fertilizer | - | 63.40 |
| $T_2$ Sheep 5% | 13.08 †† | 64.47 |
| $T_3$ Sheep 10% | 16.76 | 64.05 |
| $T_4$ Sheep 15% | 17.33 | 70.77 |
| $T_5$ Cow 5% | 14.04 | 59.07 |
| $T_6$ Cow 10% | 13.80 | 62.08 |
| $T_7$ Cow 15% | 20.45 | 62.67 |
| $T_8$Chicken 4% | 28.79 | 68.77 |
| $T_9$Chicken 8% | 32.79 | 76.65 |
| $T_{10}$Chicken 12% | 38.60 | 75.32 |
| $LSD_{0.05}$ | 6.10 | 11.56 |

† Heads were not formed in $T_0$ and $T_1$ infirst 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.**

| Treatments | Nitrate ($mg.kg^{-1}$) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | - † | 294.13 |
| $T_1$ Chemical fertilizer | - | 714.70 |
| $T_2$ Sheep 5% | 523.10 †† | 763.20 |
| $T_3$ Sheep 10% | 469.07 | 761.20 |
| $T_4$ Sheep 15% | 571.67 | 754.77 |
| $T_5$ Cow 5% | 644.97 | 662.77 |
| $T_6$ Cow 10% | 560.70 | 671.07 |
| $T_7$ Cow 15% | 644.87 | 647.17 |
| $T_8$ Chicken 4% | 756.30 | 669.77 |
| $T_9$ Chicken 8% | 770.80 | 666.63 |
| $T_{10}$ Chicken 12% | 524.33 | 715.03 |
| $LSD_{0.05}$ | 79.11 | 96.66 |

†Heads were not formed in $T_0$ and $T_1$ infirst season.

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

**Table 6: Effect of fertilizer treatments on cabbage vitamin C content in 2012 and 2013**

| Treatments | Vitamin C (mg.100g$^{-1}$Fwt) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | - † | 36.13 |
| $T_1$ Chemical fertilizer | - | 35.41 |
| $T_2$ Sheep 5% | 40.07†† | 39.25 |
| $T_3$ Sheep 10% | 35.47 | 35.86 |
| $T_4$ Sheep 15% | 38.28 | 36.47 |
| $T_5$ Cow 5% | 41.51 | 37.91 |
| $T_6$ Cow 10% | 38.14 | 36.08 |
| $T_7$ Cow 15% | 42.95 | 38.41 |
| $T_8$ Chicken 4% | 43.93 | 37.30 |
| $T_9$ Chicken 8% | 39.19 | 38.86 |
| $T_{10}$ Chicken 12% | 40.39 | 39.74 |
| $LSD_{0.05}$ | 7.04 | 3.70 |

† Heads were not formed in $T_0$ and $T_1$ infirst 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 and2013.**

| Treatments | Oxalic acid (mg.100g$^{-1}$Fwt) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | -† | 532.65 |
| $T_1$Chemical fertilizer | - | 545.30 |
| $T_2$ Sheep 5% | 583.26 †† | 646.53 |
| $T_3$ Sheep 10% | 659.18 | 557.96 |
| $T_4$ Sheep 15% | 656.46 | 646.53 |
| $T_5$ Cow 5% | 701.77 | 714.42 |
| $T_6$ Cow 10% | 557.96 | 747.75 |
| $T_7$ Cow 15% | 595.92 | 625.85 |
| $T_8$Chicken 4% | 613.19 | 444.08 |
| $T_9$Chicken 8% | 621.22 | 709.79 |
| $T_{10}$Chicken 12% | 583.26 | 646.53 |
| LSD0.05 | 99.54 | 150.85 |

†Heads were not formed in $T_0$ and $T_1$ infirst season.

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

**Table 8: Effect of fertilizer treatments on spinach leaf number and leaf area in 2012 and 2013.**

| Treatments | Leaf number. plant-1 | | Leaf area (cm2.plant-1) | |
|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 |
| T0 (Control) | 7.13 † | 10.03 | 181.44 | 561.22 |
| T1 Chemical fertilizer | 7.34 | 10.35 | 907.00 | 513.15 |
| T2 Sheep 5% | 9.69 | 10.28 | 609.98 | 595.46 |
| T3 Sheep 10% | 10.04 | 11.60 | 549.81 | 778.06 |
| T4 Sheep 15% | 10.66 | 13.23 | 844.77 | 974.24 |
| T5 Cow 5% | 9.37 | 11.77 | 592.68 | 731.58 |
| T6 Cow 10% | 9.33 | 12.90 | 1260.01 | 916.04 |
| T7 Cow 15% | 9.50 | 13.25 | 666.61 | 908.45 |
| T8 Chicken 4% | 9.43 | 10.99 | 993.05 | 1043.28 |
| T9 Chicken 8% | 11.20 | 12.71 | 1106.05 | 1211.26 |
| T10 Chicken 12% | 10.43 | 15.04 | 1609.56 | 1456.85 |
| LSD 0.05 | 1.16 | 1.82 | 537.87 | 289.54 |

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

**Table 9: Effect of fertilizer treatments on spinach yield in 2012 and 2013.**

| Treatments | Total yield ($kg.m^{-2}$) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | 0.30 † | 1.46 |
| $T_1$ Chemical fertilizer | 1.11 | 1.53 |
| $T_2$ Sheep 5% | 1.31 | 1.35 |
| $T_3$ Sheep 10% | 1.53 | 1.67 |
| $T_4$ Sheep 15% | 2.10 | 2.19 |
| $T_5$ Cow 5% | 1.96 | 2.00 |
| $T_6$ Cow 10% | 1.88 | 3.00 |
| $T_7$ Cow 15% | 1.85 | 2.75 |
| $T_8$Chicken 4% | 1.75 | 1.69 |
| $T_9$Chicken 8% | 2.94 | 3.04 |
| $T_{10}$Chicken 12% | 2.51 | 2.61 |
| $LSD_{0.05}$ | 0.39 | 0.64 |

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

**Table 10: Effect of fertilizer treatments on spinach nitrate content in 2012 and 2013.**

| Treatments | Nitrate ($mg.kg^{-1}$Dwt) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | 692.81 † | 911.15 |
| $T_1$Chemical fertilizer | 809.37 | 1152.16 |
| $T_2$ Sheep 5% | 852.77 | 1029.22 |
| $T_3$ Sheep 10% | 638.12 | 1085.50 |
| $T_4$ Sheep 15% | 907.47 | 1069.10 |
| $T_5$ Cow 5% | 748.18 | 1152.16 |
| $T_6$ Cow 10% | 927.04 | 894.75 |
| $T_7$ Cow 15% | 638.12 | 902.95 |
| $T_8$Chicken 4% | 835.32 | 981.66 |
| $T_9$Chicken 8% | 844.49 | 788.73 |
| $T_{10}$Chicken 12% | 574.25 | 622.59 |
| $LSD_{0.05}$ | 203.47 | 201.70 |

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

**Table 11: Effect of fertilizer treatments on Spinach vitamin C content in 2012 and 2013.**

| Treatments | Vitamin C (mg.100g$^{-1}$Fwt) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | 24.09 † | 26.30 |
| $T_1$ Chemical fertilizer | 30.61 | 32.63 |
| $T_2$ Sheep 5% | 25.84 | 34.13 |
| $T_3$ Sheep 10% | 33.32 | 36.08 |
| $T_4$ Sheep 15% | 35.42 | 30.30 |
| $T_5$ Cow 5% | 35.42 | 34.24 |
| $T_6$ Cow 10% | 31.56 | 27.75 |
| $T_7$ Cow 15% | 32.72 | 35.25 |
| $T_8$Chickeny 4% | 39.91 | 32.08 |
| $T_9$Chicken 8% | 41.42 | 34.91 |
| $T_{10}$Chicken 12% | 39.70 | 34.30 |
| $LSD_{0.05}$ | 8.15 | 6.07 |

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

**Table 12: Effect of fertilizer treatments on oxalic acid content of spinach in 2012 and 2013.**

| Treatments | Oxalic acid (mg.100g$^{-1}$Fwt) | |
|---|---|---|
| | 2012 | 2013 |
| $T_0$ (Control) | 1202.04 † | 1095.23 |
| $T_1$Chemical fertilizer | 1341.22 | 1366.52 |
| $T_2$ Sheep 5% | 1379.18 | 1139.99 |
| $T_3$ Sheep 10% | 1353.87 | 1290.61 |
| $T_4$ Sheep 15% | 1303.26 | 1275.78 |
| $T_5$ Cow 5% | 1303.26 | 1377.00 |
| $T_6$ Cow 10% | 1417.14 | 1204.48 |
| $T_7$ Cow 15% | 1277.95 | 1252.65 |
| $T_8$Chicken 4% | 1290.61 | 1456.32 |
| $T_9$Chicken 8% | 1037.55 | 1505.71 |
| $T_{10}$Chicken 12% | 1075.51 | 1351.69 |
| $LSD_{0.05}$ | 259.44 | 212.82 |

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

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# دور المصادر والمستويات المختلفة للأسمدة العضوية في الصفات الكمية والنوعية لحاصل اللهانة والسبانغ

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**المستخلص :**

نفذت تجربة حقلية للموسم الشتوي 2011-2012 و 2012-2013 لمقارنة إضافة السماد الكيمياوي الموصى به من قبل مطلوب وآخرون(26) مع ثلاثة مصادر من الأسمدة العضوية المخمرة في كمية ونوعية اللهانة (*Brassica oleracea* var.capitata)، صنف كوبنهاجن والسبانغ (*Spinacea oleracea* L.) الصنف المحلي. تضمنت المعاملات السماد الموصى به (RCF) ( $T_1$)، سماد الأغنام والأبقار بمستويات 5، 10و 15% (حجم/حجم) تمثل المعاملات $T_2$,$T_3$, $T_4$ ,$T_5$,$T_6$,$T_7$ على الترتيب ، وسماد الدواجن بمستويات 4، 8 و 12% (حجم/حجم)مثلث $T_8$,$T_9$,$T_{10}$ إضافة إلى معاملة المقارنة $T_0$حيث لم تضف أية أسمدة . خلطت مصادر الأسمدة العضوية حسب المعاملات قبل شتل اللهانة أو زراعة بذور السبانغ بعشرة أيام في حين أن السماد الكيمياوي الموصى به (RCF) شمل 400 كغم.هكتار$^{-1}$ من الـ DAP ( الفوسفات ثنائية الأمونيوم) + 60 كغم.هكتار$^{-1}$ من اليوريا لكل محصول . أضيف سماد الـ DAP أسفل خط النباتات في خندق بعد أسبوعين من شتل اللهانة أو تكامل إنبات السبانغ . أضيفت اليوريا بعد مرور شهر من إضافة الـ DAP وبنفس الطريقة . وزعت المعاملات حسب تصميم القطاعات الكاملة المعشاة RCBD بثلاثة مكررات . ويمكن إيجاز النتائج كالآتي :

سماد الدواجن المخمر بمستوى 12% ($T_{10}$) إنتجت أكبر وزن للرؤوس في اللهانة في كلا الموسمين (926.4 و 1981.5 غم )على الترتيب . أعلى إنتاجية في الموسم الأول كانت عند المعاملة $T_{10}$ (38.60 طن.هكتار$^{-1}$) بينما في الموسم الثاني كانت عند المعاملة $T_9$ (76.65 طن.هكتار$^{-1}$) . محتوى الرؤوس من النترات ($NO_3^-$) كان مرتفع في النباتات المسمدة سواء بالأسمدة الكيمياوية أو العضوية مقارنة بنباتات القياس لكن المحتوى لم يصل إلى المستوى المؤثر في صحة الإنسان .أعلى

مستوى من فيتامين C وجد في اللهانة المسمدة بالمعاملتين $T_7$و$T_8$ (43.93 ، 42.95 ملغم.100 غم$^{-1}$وزن طري) . أعلى تركيز لحامض الأوكزاليك وجد في المعاملات $T_6,T_5,T_5$في الموسمين على الترتيب والتي تمثل معاملات سماد الأبقار .

أعلى حاصل من السبانغ نتج من المعاملات بالأسمدة العضوية وبأعلى المستويات بغض النظر عن المصدر وأعلاها في المعاملة $T_9$ للموسمين (2.94 و 3.04 كغم.م$^{-2}$) مقارنة بمعاملة السماد الكيمياوي (RCF) ($T_1$) (1.11 و 1.53 كغم.م$^{-2}$) للموسمين على الترتيب . أعلى محتوى من النترات في السبانغ وجدت في المعاملة $T_6$ في الموسم الأول و$T_1$ و $T_5$ في الموسم الثاني . أعلى محتوى من فيتامين C وجد في المعاملة $T_9$ في الموسم الأول و $T_3$ في الموسم الثاني . لم يظهر حامض الأوكزاليك إتجاه معين حيث أعلى تركيز ظهر في $T_3$ في الموسم الأول في حين كان في $T_9$ في الموسم الثاني .

كلمات مفتاحية : أسمدة عضوية مخمرة ، لهانة ، سبانغ

* جزء من أطروحة دكتوراه للباحث الأول .