Effect of Organic Fertilization and Mulching on Growth and Yield of Brassica Oleracea L. Var. Capitata

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Abstract

The experiment was carried out at the Research Station of the Department of Horticulture dept. of Tikrit University for the season 2020-2021 to investigate the effect of organic fertilization with treatments (control, poultry manure, and Humobacter fertilizer) and mulching type with four Mulching type (no mulching, black mulch, white mulch, and yellow mulch). A randomized complete blocks (RCBD) design and a split-plot method were used in the experiment, which included three replications. The Humobacter fertilizer treatment considerably outperformed of plant height, and overall plant yield, which were 21.69 cm, and 46.55 tons⁻¹, respectively, compared to 19.03 cm, and 28.10 tons⁻¹, respectively. As for the mulch treatments, the yellow mulch treatments were achieved the best values of number leaves, plant yield for one plant and the total plant yield, 16.81 leaf⁻¹, 50.38 cm, 1.42 kg and 47.31 tons⁻¹, respectively.

Keywords: Fertilization, Oleracea, Capitata.

1. Introduction

Cabbage is a popular winter vegetable crop in Iraq, with the scientific name Brassica oleracea L. Var.Capitata. It is a member of the Brassicaceae family [1]. There are around 300 genera and 3000 species of plants in this family, which are found all over the world. The eastern Mediterranean is where cabbage originated. It thrives in moderately chilly and humid conditions. In terms of value, the edible section and the head that contains the coiled leaves, it is the second most important crop in the Brassicaceae family after cauliflower. Its heads are used in cooking, salads, pickling, and canning, among other things [2,3]. Each 100 gm of fresh leaves contains 6.1_11.2% dry matter, 3_54% carbohydrates, 1-2% proteins, 0-2% fats, 30-50% vitamin C, 130 IU vitamin A, 0.05 mg thiamine, 238 mg potassium, 49 mg phosphorous, 9 mg magnesium, 1.2 mg iron, and 24 mg calories [16; 9], probably that fertilizers and pesticides is likely to result in an increase in nitrate concentrations in fruits, which will have a negative impact on human health and the environment in general, as well as contamination of groundwater and a reduction in soil organic matter proportions, beneficial organisms, and natural enemies that cause pathogenesis [4,5].

Fertilizers Led to soil degradation and environmental pollution in the long term, chemical fertilizers frequently decay soil fertility and the decreasing harvest efficiency because of supplement irregularity in the soil, which has been perceived as a standout amongst the most imperative factors that limit crop yield. However, Mineral fertilizers also play an essential role in increasing the production of crops [6,7]. Organic fertilizers of various types, plants and animals, began to be used in the production of vegetable crops in the middle of the last century as a way to decrease or replace the use of chemical fertilizers [8,9], is considered one of the production inputs that contribute effectively in agricultural development and food security. This also reduces the gap between the produced quantities and imported food [10,11]. Mulching is an important method employed by farmers since it increases the moisture content of the soil by 57 % when compared to the non-mulching treatment. This is due to the soil's enhanced ability to conserve water and hence the lack of evaporation from the soil surface [12,13]. Mulching the soil reduced salinity in both the horizontal and vertical directions, reduced nutrient loss, and prevented bush growth, depending on the type of soil mulch used, all of which helped to boost production and preserve the soil's qualities [14,15]. The study's objectives were to study effect of organic fertilization and mulching on Cabbage growth and yield, as well as how much chemical fertilization can be minimized to produce ecologically friendly or safer foods.
2. Materials and Methods

For the autumn planting season 2021-2020, the experiment was conducted at the Research Station of the Department of Horticulture and Landscaping Engineering - College of Agriculture - Tikrit University, with the aim of studying the effect of organic fertilization and soil mulching on the growth and yield of red cabbage. Samples of field soil were gathered with the purpose of determining its chemical and physical qualities in the field for a variety of locations and depths (0-30). After plowing the field twice with the flip-plow, the large clay lumps were disintegrated with the hoe, and the soil was leveled well and uniformly. It was then separated into lines. The seeds were planted in cork dishes in the Green Land Nursery Baghdad / Yusufiyah on 1/9/2020, and the seedlings were trimmed when they reached the stage of forming the third or fourth true leaf, and the seedling process was completed on 10-17-2020.

The seedlings were planted in the middle of the line and on one side of the line with a length of 6 meters, a distance between one line and the next of 1 meter, two lines per experimental unit, ten plants per experimental unit, and a gap between one seedling and the next of 25 cm. The experiment included 12 experimental units and three duplicates and used drip irrigation with a drip tube for each line. Agricultural service operations were carried out for farmers in the cultivation area, from the beginning of the seedling operation to the end of harvesting the heads, as is the case in cabbage fields, including irrigation, weeding, hoeing the soil, and removing the bush as needed. Within the RCBD design, the experiment was carried out using a split-plot design. Mulching was used on the main plots, while organic fertilization was used on the sub-plots. The treatments were distributed in three replications at random. All data were statistically analyzed, and the treatments' arithmetic values were compared using the Duncan polynomial test at a probability level of 0.05. [16].

2.1 The experiment included the following factors

- The first factor: Mulching (main-plot) and includes:
  ((without mulch, black mulch, white mulch, yellow mulch))
- The second factor: fertilization (sub-plot) and includes:
  Without fertilizer
  Poultry decomposed manure's
  Humobacter fertilizer

2.2 Studied characteristics

(plant height (cm), number of outer leaves (leaf⁻¹), leaf area per leaf (cm²), head circumference (cm), yield of one plant (kg plant⁻¹), total marketable yield (ton H⁻¹)

3. Results and Discussion

3.1 Plant height(cm)

Table 1 shown that there were significant differences between the treatments, with the organic fertilization treatment excelling when fertilizing with Humobacter and giving the maximum plant height of 21.69 cm compared to the lowest height of 19.03 cm for the no fertilization treatment. As it came to the mulch treatment, all three mulch treatments yielded the maximum heights of 21.28, 21.36, and 20.90 cm, respectively, when compared to the comparison treatment, which yielded the lowest height of 18.27 cm.

A significant differences has been shown of the bilateral interaction between organic fertilization and the type of mulch in the same table, as the treatment of Humobacter fertilization excelled when using white mulch and had the highest height of 23.13 cm, compared to the lowest height of 17.57 cm when neither the fertilizer nor the mulch was used.
Table 1. Effect of organic fertilization, type of mulching on plant height (cm).

| Treatment       | Control | Black mulch | White mulch | Yellow mulch | Fertilization effect |
|-----------------|---------|-------------|-------------|--------------|---------------------|
| Control         | 17.57 f | 20.47 cd    | 19.60 de    | 18.47 ef     | 19.03 c             |
| Poultry manure  | 18.53 ef| 21.27 bc    | 21.33 bc    | 21.40 bc     | 20.63 b             |
| Humobacter      | 18.70 ef| 22.10 ab    | 23.13 a     | 22.83 a      | 21.69 a             |
| Mulching effect | 18.27 b | 21.28 a     | 21.36 a     | 20.90 a      |                     |

* The values s of the treatments with similar letters are not significantly different from each other according to Duncan's test under the 0.05 probability level.

3.2 Number of outer leaves (leaf⁻¹)

Table 2 shown that there significant effect of organic fertilization, type of Mulching, and the interaction between them on the number of leaves, the poultry and Humobacter fertilization achieved the highest values in number of leaves 16.88 and 16.93 leaves⁻¹, respectively. The mulching types shown a significant effect, the yellow mulch had achieved the highest rate of leaf number at 16.81 leaf⁻¹, whilst the white mulch had the lowest number of leaves at 15.96 leaf⁻¹. A significant differences between the interaction treatments has shown, the fertilization with Humobacter fertilizer when using yellow mulch producing the highest number of outer leaves (18.07 leaf⁻¹) compared to the lowest number of leaves (15.00 leaf⁻¹) when the treatment of no addition and use of fertilizer white mulch was used.

Table 2. Effect of organic fertilization, type of mulching on the number of leaves (leaf⁻¹).

| Treatment       | Control | Black mulch | White mulch | Yellow mulch | Fertilization effect |
|-----------------|---------|-------------|-------------|--------------|---------------------|
| Control         | 15.60 def| 15.90 cdef  | 15.00 f     | 15.43 ef     | 15.48 b             |
| Poultry manure  | 17.27 ab | 17.13 ab    | 16.20 bcde  | 16.93 abc    | 16.88 a             |
| Humobacter      | 16.43 bcde| 16.53 bcde  | 16.67 bcd   | 18.07 a      | 16.93 a             |
| Mulching effect | 16.43 ab | 16.52 ab    | 15.96 b     | 16.81 a      |                     |

* The values s of the treatments with similar letters are not significantly different from each other according to Duncan's test under the 0.05 probability level.

The results shown that there is a significant increase in vegetative growth, which is fertilized with poultry manure and Humobacter manure in plant height, number of leaves, as shown in Tables 1 and 2, respectively.

The increasing in vegetative growth characteristics caused by organic fertilizer treatments, poultry manure, and Humobacter manure, may be due to the fact that organic fertilizers provide appropriate amounts of nutrients around the root area, resulting in increased nutrient absorption by the plant and thus an increase in vegetative growth, including an increase in Plant height, number and leaves [17] and this is in agreement with [18]. The reason for this could be that organic fertilizers improved the physical properties of the soil by increasing its granularity by combining organic matter with small clay granules, which increase the permeability, porosity, and aeration of the soil and provide the oxygen required for microorganism activity and root respiration. They also improve clay soils' ability to retain water and limit the process of evaporation, resulting in a rise in plant height and number of leaves [19]. The increasing of plant height when covered of plastic Mulching, because that plastic mulches led to decrease the soil moisture loss. Mulching helps to keep a consistent moisture level in the soil [20]. The plastic mulches boosts the temperature of the soil by 2-10 degrees Celsius [21]. It also inhibits the growth of weeds which compete the crops, allowing the plant to expand more quickly. Yellow plastic mulching helps the soil retain irrigation water, reduce evaporation, and boost moisture stock, which led to a significant increase in the number of outer leaves, and this is consistent with [22] on cauliflower.

3.3 Head circumference (cm)

There were significant differences between the treatments in Table 3 which shown the effect of organic fertilization, the type of mulching, and the interaction between them on the characteristic of head circumference, as all treatments of adding organic
manure, poultry manure, and Humobacter achieved the highest values in head circumference of 48.88 and 48.71 cm, respectively. Compared to the smallest head circumference in the control, it was 43.29 cm. The treatment with yellow mulch, which produced the maximum head circumference of 50.38 cm, outperformed the comparative treatment without the mulch, which produced the shortest head circumference of 40.08 cm. The results showed that there were significant differences between the interaction treatments in the table 3, the Humobacter fertilization with yellow mulch achieved the largest head circumference of 52.70 cm compared to the control.

**Table 3.** Effect of organic fertilization, type of mulching on head circumference (cm).

| Treatment                  | Control | Black mulch | White mulch | Yellow mulch | Fertilization effect |
|----------------------------|---------|-------------|-------------|--------------|---------------------|
| Poultry manure             | 37.33 f | 44.20 de    | 45.27 d     | 46.37 cd     | 43.29 b             |
| Humobacter                 | 41.83 e | 50.27 ab    | 51.33 ab    | 52.07 ab     | 48.88 a             |
| Mulching effect            | 41.07 e | 48.87 bc    | 52.20 ab    | 52.70 a      | 48.71 a             |
| Black mulch                | 40.08 c | 47.78 b     | 49.60 ab    | 50.38 a      |                     |

* The values of the treatments with similar letters are not significantly different from each other according to Duncan's test under the 0.05 probability level.

**3.4 Total yield (tons H⁻¹)**

Table 4 shows that organic fertilization and mulching type achieved highest values in total yield. There are significant differences between the treatments, such as the Humobacter fertilization treatment, which had the highest total yield rate of 46.55 tons H⁻¹ compared to the lowest yield rate of 28.10 tons H⁻¹ in the comparison treatment. As for the mulching treatments in the table 4, the yellow mulch treatment was give the highest yield rate of 47.31 tons H⁻¹ compared to the lowest yield rate of 24.19 tons H⁻¹ in control treatment, with an increase of 95.58%. In terms of interaction factors, the results show that there are significant differences between the treatments, with the treatment of adding organic fertilization, Humobacter when with yellow mulch achieved the highest values weight of total yield of 58.76 tons H⁻¹, compared to the lowest rate of total yield of 19.20 tons H⁻¹ with a 206.04 % increase.

**Table 4.** Effect of organic fertilization, type of mulching on Total yield (tons H⁻¹).

| Treatment                  | Control | Black mulch | White mulch | Yellow mulch | Fertilization effect |
|----------------------------|---------|-------------|-------------|--------------|---------------------|
| Poultry manure             | 19.20 e | 32.00 cd    | 28.06 d     | 36.73 c      | 28.10 c             |
| Humobacter                 | 26.98 d | 46.11 b     | 43.11 b     | 46.44 b      | 40.66 b             |
| Mulching effect            | 26.40 d | 45.35 b     | 55.71 a     | 58.76 a      | 46.55 a             |
| Black mulch                | 24.19 c | 41.15 b     | 42.29 b     | 47.31 a      |                     |

* The values of the treatments with similar letters are not significantly different from each other according to Duncan's test under the 0.05 probability level.

The addition of organic manure poultry manure and Humobacter resulted in a considerable increase in yield characteristics such as head circumference, as indicated in Tables 3, and 4 on straight. In general, organic additives increased the organic matter in the soil, which improved its properties by increasing the availability of nutrients, increasing the activity and quantity of microorganisms in the soil, and then increasing the effectiveness of enzymes that decompose organic matter in the soil, thereby increasing the elements' and t's readiness [23], [24], this was reflected in an increase in the previously mentioned traits.

The plastic mulch increased the temperature of the soil by releasing carbon dioxide CO₂, which is concentrated near the lower area of the plants, as well as maintaining moisture and reducing some insect pests, affecting the root system's absorption efficiency. As a result, water and nutrients increase the amount of carbohydrates in the leaves, accelerating their development and growth and so increasing the yield [25,26]. These confirmed from [27,28] Increasing the weight and diameter of syphilis as well as the total production of cauliflower when mulched.
References

[1] Abass, D. K., al-Janabi, A.H.and Rachid, M.A. (2015). Effect of irrigation water quality and organic and mineral fertilization on the availability of some nutrient elements and cabbage yield (Brassica oleracea var. capitata L.). Euphrates Journal of Agriculture Science, 7(4):235-247

[2] Abo –Hinna, M. A. and T. K Merza. (2012). Effect of organic manure, tuber weight and ascorbic acid spraying on some vegetative parameters and marketable yield of potato (Solanum tuberosum L.) grown in sandy soil. Kufa Journal of Agricultural Sciences: 4(1):15-29.

[3] Abu Rayan, Azmi Muhammad.(2010). Organic agriculture (its characteristics and importance in human health. Department of Horticulture and Crops. College of Agriculture. University of Jordan. first edition. Wa'il Publishing House, Amman. Jordan. 322 p.

[4] Ali, N.M., D.K.A. Al-Taba and N. H. Altace.(2021). The Impact of Selenium, Nano (SiO2) and Organic Fertilization on growth and yield of Potato Solanum tuberosum L. under Salt Stress Conditions. IOP Conf. Ser.: Earth Environ. Sci. 735:012042

[5] Al-Janabi, M. A.A. (2005). Evaluation of Drip Irrigation for Allium cepa L. Onion under Coverings and Soil Organic Matter. Master Thesis. College of Agriculture. Anbar University.

[6] Al-Kamar, M. K. and M. A. Al-Assaf (2001). Effect of partial mulching and planting dates on growth and seed production of cauliflower. Iraqi Journal of Agricultural Sciences (special issue). 7 (3).

[7] Al-Rawi, A.A. A ., K. M. T. Khalaf and N. H. Athab. (1995). Effect of mulching soil with polyethylene film on some soil properties and tomato growth and production. Rafidain Agriculture Journal. Mosul. (27). (3) 24-27.

[8] Al-Rawi, K. M. and A. M. Khalaf Allah (1980). Design and analysis of agricultural experiments. University of Mosul - Ministry of Higher Education and Scientific Research – Al-Kutub for Printing and Publishing – Iraq.

[9] Al-Taey D.K.A., Al-Janabi A.H., and A.M. Rachid. (2019). Role of Additive in Mitigation of the Negative Effects of Saline Water on Cabbage (Brassica oleracea var. Capitata L. Plant Archives Vol. 19. Supplement 1, 2019 pp. 78-85

[10] Al-Taey, D.K.A., NAeely, I. J.C., Khash B.H. (2019). A study on effects of water quality, cultivars, organic and chemical fertilizers on potato (Solanum tuberosum L.) growth and yield to calculate the economic feasibility. Bulgarian Journal of Agricultural Science, 25 (6) 1239-1245.

[11] Al-Taey, D.K.A., Al-Janabi A.S.H. and Rachid A.M. (2017). Effect of water salinity, Organic and minerals fertilization on growth and some nutrients elements in cabbage Brassica oleracea varapitate. Babylon Journal of Pure and Applied science, 25(6): 2046-2064, https://www.journalofbabylon.com/index.php/JUBPAS/article/view/300/152

[12] Appiredy, G. K S . Saha B. L. Mina S. Kundu G. Selva kumar and H. S. Gupta. (2008). Effect of organic manures and integrated management on yield potential of bell pepper (Capsicum annuum) varieties and on soil properties Arch. Agron . Soil Sci. 24: 127 – 137.

[13] Atti, A. S. and F. H. Al-Sahaf. (2007). Potato production by organic farming. The role of organic fertilizers and spraying in the characteristics of microorganisms, Iraqi Journal of Agricultural Sciences, 38 (4): 36-51.

[14] Baron, J. J. and S. F. Gorske (1981). Soil carbon dioxide levels as affected by plastic mulches. Proc., 16th Natl, Agr. Plastics Congr., PP. 149-155.

[15] Bichkule.C. V. (2015). Effect of different shading intensities and mulching on growth and yield of cauliflower (Doctoral dissertation, MPKV, UNIVERSITY LIBRARY).

[16] Boursas, M., B. Abu Turab and I. Al-Basit. (2011). Production of vegetable crops. The theoretical part. Al-Ajloni Press. Damascus University. University of Agriculture. Syria.

[17] Burhan El-Din A.H., and I. A. Mohamed. (2017). Effect of soil mulching and planting date on growth and yield of two cauliflower hybrids, Brassica oleracea var. Botrytis. Kirkuk University Journal of Agricultural Sciences Issue 17 No. 4 Pg. 1813-1646

[18] Hamza O.M. and D. K. A. AL-Taey.(2020). A study on the effect of glutamic acid and benzyl adenine application up on growth and yield parameters and active components of two Broccoli hybrids. Int. J. Agricult. Stat. Sci., 16, Supplement 1: 1163-1167. DocID: https://connectjournals.com/03899.2020.16.1163

[19] Hassan, A. A. M. (2003). The production of cruciferous and sour vegetables, first edition. The Arab House for Publishing and Distribution, Cairo.

[20] Hayes M. H. B and C. E. Clapp (2001). Humic substances: considerations of compositions aspects of structure and environment influences. J. Soil Sci. 166, 11: 723 – 737.

[21] Kirank, H.; c.Kaya:D.Higgs and S.Gereek. (2001). Along term experiment to study the role of mulches in the physiology and macro nutrition of strawberry grown under water strees. Aust. Agric. Research, 52: 937-943.

[22] Lamont, W.J. (1993). Plastic mulches for production of Vegetable crop . Horticulture Technology , (3) : 35 – 39.

[23] Manea, A.I., AL-Bayati, H.J and AL-Taey, D.K.A. (2019). Impact of yeast extract, zinc sulphate and organic fertilizers spraying on potato growth and yield. Res. on Crops 20 (1) : 95-100. DOI: 10.31830/2348-7542.2019.013

[24] Al-Hakeem M. and M.S. Muhammad (2006). The effect of the number of plants in the hole, the planting distance between plants, and covering the soil with plastic on the growth and yield. M.A. thesis. Department of Plant Production Techniques, technical College. Al-Musayyab: 113 pages.

[25] Osman, J. Y. (2007). Study of the effect of using organic fertilizers in potato cultivation and production as a contribution to clean organic production. Master Thesis - College of Agriculture - Department of Horticulture - Tishreen University - Lattakia - Syrian Arab Republic.
[26] Sibale, D. (2015). Response of cauliflower (Brassica Oleracea L.) to various mulches and irrigation levels under drip irrigation (Doctoral dissertation, DBS KKV DAPOLI).

[27] Slomy A.K., A. K. Jasman, F. J. Kadhim, D. K.A. AL-Taey and M. R. Sahib (2019). STUDY IMPACT OF SOME BIOFACTORS ON THE EGGPLANT SOLANUM MEONGENA L. VEGETATIVE CHARACTERISTICS UNDER GLASS HOUSES CONDITIONS. Int. J. Agricult. Stat. Sci. Vol. 15 (1) :371-374

[28] Toman S.S., D. K. A. AL-Taey, A. R. Al-Tawaha, S. N. Sirajuddin, I. Rasyid and A. A. Hassan. (2020). Effect of foliar application and mineral fertilizer on growth parameters and content auxins, GA and CK in cucumber leaves. IOP Conf. Ser.: Earth Environ. Sci. (492) 012009, doi:10.1088/1755-1315/492/1/012009.