Effect of Chemical, Organic and Bio Fertilization on Growth and Yield of Strawberry Plant

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Abstract: *The experiment was carried out in the Depar. Of Horti. - Col. Of Agric. Univ. Of Baghdad, 2015-2016, in order to study the effect of fertilizer combinations included mineral fertilizers, foliar application (Karma), organic (Blak Force) and Bio-fertilizers (Biohelth) on the growth and production of strawberry, Fragaria x ananassa Duch Var. Festival. It has been studied adjectives of vegetative growth as the number of leaves, crowns, leaf area, leaf content of chlorophyll, leaf content of (NPK), fruits number,weight, size, Tss %, Anthocyanin and plant yield. The results confirmed, superiority of treatment involved mineral, organic and biological fertilizer, in leaf content of NPK compared to other treatments, this combination of fertilizer significantly increased leaf area (529.66) Cm^2. $Plant^{-1}$, number of Leaves (28.56), number of fruits 33.73, and the total production of the plant, 367.24g. $Plant^{-1}$. Anthocyanin concentrations increased significantly in the fruits 52.67 mg. 100 g^{-1} fresh weight, as well as elevation in the ratio of soluble solids to acidity T.S.S: pH was 1.35.*

Keyword: *Strawberry, Mineral, Organic, Bio-fertilizers.*

1. Introduction

Strawberries have become one of the important fruits in Iraq recently, Spread grew quickly in the central and southern areas of Iraq with different ecological conditions because of the numerous benefits to human health. Strawberry plants need large amounts of fertilizer due to its high production despite the small size of the plant (Morgan, 2006). Farmers in recent decades went to reduce the chemical fertilizer by using alternatives to chemical fertilizer such as organic fertilizer and bio-fertilizer to reduce pollution while maintaining production and quality.

Bio-fertilizer is a derived product of living microorganism (useful bacteria and fungi) which play an important role in improving soil fertility by Nitrogen fixing, solubilise insoluble soil phosphates, Potassium removable and Enhances plant production By growth stimulate materials (Han et al., 2006, Venkatashwarlu, 2008). In sustainable agriculture Biofertilizers used as an alternative to mineral fertilizers for increasing soil productivity and plant growth. The effect of bio- inoculants on growth of strawberry "Sujatha' increased number of leaves per plant, leaf area and leaf chlorophyll content (Wasi-Amiri et al., 2011)

Organic substance Improve Physical and chemical Soil characters, prevent soil degradation and increase beneficial important micro organisms. Organic fertilizers improved strawberries yield due to their essential elements, vitamins, enzymes and hormone. Many studies have confirmed that application of organic manure to strawberry fields improved plant nutrition and stimulate plant growth (Hargreaves et al., 2009). Wang and Lin (2002) used 100% compost, manure as a soil supplement in strawberry growing CVs. Allstar and Honeoye, indicated a significantly enhanced strawberry plant growth. Plants produced higher vegetative growth and the production increased in Organic cultured in comparing to conventionally cultured strawberries (Palomaki et al., 2002, Shehata et al. 2011).

Flowering date advanced by organic matter, while it was delayed in the conventional treatment,while the highest fruit weight and total yield per plant were produced in conventional treatment. (Abu-Zahra and Tahboub, 2008)

Plant growth promoting bio-fertilizer application increased organic manure use efficiency and have the capacity to stimulate strawberry growth and yield (Karlidag et al., 2009). Glinicki et al. (2011), revealed that NPK fertilization with single microbial inoculation applied to strawberry plants can withstand the positive effect

on strawberry plant growth. Strawberry, CV. Festival organically cultured fertilized mineral nutrition showed a significant increase in a number of leaves, leaf area, and number of crowns per plant. (Khalil, 2014)
Kumar, et al. (2015) indicated that treatments combination organic manure + Biofertilizers has shown significant effects on most of the vegetative growth parameters, fruit setting and Total Soluble Solids in strawberry plants. Adding Biofertilizer effective microorganisms and Biofertile combined with 100% of the recommended dose of NPK as mineral fertilizers and compost increased, most of plant growth characters, chemical composition, total fruit yield and its components, physical quality and chemical constituents of fruits. (Hassan2015).

The investigation aimed to evaluate the effect of mineral, organic, and bio fertilization on growth, yield and quality of strawberry, also to study compensation possibilities for mineral fertilizers, with organic and bio-fertilizer.

2. Materials and Methods

A study was conducted in an unheated polyethylene greenhouse unit (9m wide and 30m long) of the Department of Horticulture and Landscape - College of Agriculture - University of Baghdad in the 2015-2016 growing periods. Strawberry Festival (*Fragaria x ananassa* L. Duch.) which originated from 1995 across between 'Rosa Linda' and 'Oso Grande' (Chandler, et al 2000) was used as plant materials, and planted on 20th of October with standard, two-row beds. A randomized complete block design was employed as the experimental design with three replications. Treatments consisted of:

1- Mineral fertilizer 100%, recommended dose of NPK (F1)
2- Mineral fertilizer 50% + organic fertilizer (Manuer extract Blak Force) (F2)
3- Mineral fertilizer 50% + Bio-fertilizer (Biohelth) (F3)
4- Mineral fertilizer 50% + organic fertilizer+ Bio-fertilizer. (F4)
5- Organic fertilizer + mineral fertilizers as a foliar application (Karma). (F5)
6- Bio-fertilizer + Organic fertilizer+ mineral fertilizers as a foliar application (F6)

Fertilizers were applied three weeks after planting periodically 10 day intervals, using drip irrigation system. The plants in treatments F3, F4 and F6 applied with bio-fertilizer Which consists of Trichoderma and Bacillus strains with humic acids and seaweed extract once a month during the growing season, While the plants in F5 and F6 Sprayed with 2gm. L^{-1} Foliar application (karma) Which consists of NPK+TE periodically 10 day intervals.

Data were analyzed by analysis of variance (ANOVA) using the Ginstat statistical program and means were compared using LSD test at 5 % of probability.

Vegetative growth data Were recorded to determine Number of leaves / plant, Leaf area, Number of Crown/ plant, leaf chlorophyll content (mg. 100 g^{-1} fresh weight) and the percentage of total nitrogen, phosphorus and potassium of plant foliage were determined. Fruit characteristics were a number of fruits / plant, fruit size (cm^3), fruit weight (gm) and plant yield (gm /plant), fruit quality as Total Soluble Solid percentage (TSS%), Acidity (pH), TSS: pH ratio and anthocyanin (mg. 100 g^{-1} fresh weight).

3. Results and Discussion

Chemical compositions of plant leaf

As a result of using different fertilizers rates there were a significant increments in leaf chemical constitutes of NPK, data in Table 1 show that the leaf content of total nitrogen percentage significantly increased by the application of combinatorial consist of Bio-fertilizer, Organic and mineral fertilizers as a foliar application (2.50%), with no significant differences for the plants mineral fertilized 100% (2.40%), while the lowest value indicated in F2 treatment plants (2.16%). There were no significant differences between plants in F3, f4 and F5 compared to F1 (Mineral fertilizer 100%). The highest leaf content of total Phosphorus and Potassium percentage recorded in plants fertilized with combinatorial consists of Mineral 50% + Bio-fertilizer P (1.25%) and K (1.99%), Whereas the lowest values were recorded in F4 and F6 plants. The increasing of leaf content of N, P and K may be due to the increase of these nutrients in the roots biosphere With the addition of fertilizer, which led to Increasing the uptake and accumulation of these elements. Vessy (2003) indicated that Bio-

fertilizer increased the supply or availability of essential nutrients and promote plant growth. The results agree with Abo Sedera et al. (2010), Esitken et al., (2010) and Hassan, (2015).

Considering that potassium and phosphorus was applied at recommended rates, it is possible that their uptake was enhanced by nitrogen fertilizers which have been reported by mediate the uptake and utilization of potassium, phosphorus and other elements in plants (Brandy, 1984).

TABLE 1: Effect of combination of mineral, organic and bio-fertilizers application on chemical constituents of strawberry plants leaves.

Treatments	N%	P %	P%
Mineral fertilizer 100% (F1)	2.40	1.06	1.66
Mineral 50% + organic fertilizer (F2)	2.16	1.07	1.86
Mineral 50% + Bio-fertilizer (F3)	2.36	1.25	1.99
Mineral 50% + organic + Bio-fertilizer (F4)	2.30	0.97	1.85
Organic + mineral fertilizers as a foliar application (F5)	2.30	1.20	1. 99
Bio + Organic + mineral fertilizers as a foliar application (F6)	2.50	1.01	1.63
LSD	0.113	0.023	0.057

Vegetative growth

The results in table 2 indicate that Bio- fertilizer combined with 50% Mineral fertilizer (F3) gave the highest values of a number of leaves/ plant, crown/ plant, and leaf area (28.56, 2.56 and 529.66 cm^2) respectively, when compared with other treatments, while the lowest values were (20.66, 2.00 and 456.53 cm^2) in F4, F5and F1 treatments respectively. The data in the table 2 observed that the leaf content of chlorophyll significantly increased by the application of combinatorial consist of Bio-fertilizer, Organic and mineral fertilizers as a foliar application (F6) which was 177.98 mg. 100 g^{-1}, with no significant differences for the plants in treatment F2, consist of Mineral 50% and organic fertilizer (172.29 mg. 100 g^{-1}), while the lowest leaf content of chlorophyll was in plants fertilized with 100% Mineral fertilizer (144.23 mg. 100 g^{-1}). The results Probably caused by macro-nutrients (N, P and K) in leaves (table 1) accumulated in the leaves because the addition of various fertilizers, these elements involved in the most vital activities, synthesis of chlorophyll, enzymes, amino acids, proteins and the process of photosynthesis and assimilation rate for precursors of carbohydrates, they are helpful in cell elongation and cell division by plant growth substances such IAA and GA, which causes increased the vegetative growth (Rathi and Bist, 2004; Taiz and Zeiger, 2010; Kumar, et al. 2015). The results obtained were Similar to Awad et al. (2010); Wasi-Amiri et al.(2011) ; Hassan, (2015) and Kumar, et al. (2015).

TABLE 2: Effect of combination of mineral, organic and bio-fertilizers application on vegetative growth of strawberry plants.

Treatments	Number of leaves	Leaf area (cm^2)	Number of Crown	Chlorophyll mg. 100 g^{-1}
Mineral fertilizer 100% (F1)	20.66	456.53	2.16	144.23
Mineral 50% + organic fertilizer (F2)	26.96	502.30	2.10	172.29
Mineral 50% + Bio-fertilizer (F3)	28.56	529.66	2.56	158.84
Mineral 50% + organic + Bio-fertilizer (F4)	20.66	462.93	2.43	166.90
Organic + mineral fertilizers as a foliar application (F5)	24.33	496.90	2.00	168.69
Bio + Organic + mineral fertilizers as a foliar application (F6)	28.30	508.80	2.43	177.98
LSD	1.43	12.09	0.175	8.561

Fruit yield and components

The results in table 3 indicated the superiority of plants fertilized with the combination of Mineral 50% and Bio-fertilizer (F3) in the Number of fruits / plant (33.37), Fruit weight (11.30 gm) and Total Plant yield (367.12 gm), when compared to the other treatments, while there were no Significant differences between F3,F4,F5 and F6 treatments in fruit size, as the largest fruit size recorded in F5 plants (25.83 cm^3) While the smaller fruit size recorded in F1 plants (23.36cm^3). The less value of Number of fruits/ plant was 27.23 in plants

fertilized with the Recommended Mineral fertilizer 100% (F1), the lowest Fruit weight and Total Plant yield were 8.13 gm and 258.12gm respectively. These results may due to the effectiveness of Various types of fertilization on plant chemicals Components and improvement vegetative characteristics (table 1 and 2) that positively related with the plant yield. Similar results were obtained by Abo Sedera et al. (2010), Esitken et al.(2010), Glinicki et al. (2011), khalil (2014), Hassan, (2015) and Kumar, et al. (2015). They indicated that growth of strawberry plant was significantly influenced by organic and biofertilizer with or without synthetic mineral fertilizer.

TABLE 3: Effect of combination of mineral, organic and bio-fertilizers application on number of fruits, fruit weight and total plant yield.

Treatments	Number of fruits	Fruit size Cm^3	Fruit weight (g)	Total Plant yield (g)
Mineral fertilizer 100% (F1)	27.23	23.36	11.23	314.81
Mineral 50% + organic fertilizer (F2)	32.63	23.76	11.23	362.24
Mineral 50% + Bio-fertilizer (F3)	33.73	25.00	11.30	367.12
Mineral 50% + organic + Bio-fertilizer (F4)	31.20	25.00	9.63	297.64
Organic + mineral fertilizers as a foliar application (F5)	28.90	25.83	11.30	326.49
Bio + Organic + mineral fertilizers as a foliar application (F6)	31.86	25.00	8.13	258.12
LSD	1.94	0.99	0.57	7.43

Generally enhancement plant growth and yield as affected by organic and bio- fertilizer could be explained by the ability of N2-fixation, P- solubilising, Indole acetic acid (IAA) and antimicrobial substance production (Cakmakci et al; 2007; Elkoca et al., 2008).

Fruit quality

Data presented in Table 4 observed no significant effects of the treatments on the fruit acidity which was measured as pH of the juice. The data indicated chemical constituents of fruit, as TSS%, TSS: pH and Anthocyanin significantly increased by the application of combination of Mineral 50% and Bio-fertilizer to the plants. The highest values were TSS (5.73%) and TSS: pH (1.35). Anthocyanins recorded the highest value in F3 and F4 fruits with no significant differences (52.67and 51.97 mg. 100 g^{-1}) respectively, when compared to the other treatments, whereas the lowest value was (39.71 mg. 100 g^{-1}) in F1 plants. These results may due to the synergistic effect of macronutrients NPK supplied by Mineral, Organic and Bio-fertilizer which improved vegetative characteristics and affect the synthesis of chlorophyll that hence the process of photosynthesis and the assimilation of carbon dioxide which lead to increment fruit quality (Jasso- chaverria et al., 2005).

TABLE 4: Effect of combination of mineral, organic and bio-fertilizers application on fruits pH, TSS, pH: TSS, and Anthocyanin mg. 100 g^{-1} fresh weight.

Treatments	pH	T.S.S%	T.S.S: pH	Anthocyanin (mg. 100 g^{-1})
Mineral fertilizer 100% (F1)	4.20	5.03	1.20	39.71
Mineral 50% + organic fertilizer (F2)	4.30	5.33	1.16	49.96
Mineral 50% + Bio-fertilizer (F3)	4.23	5.73	1.35	51.97
Mineral 50% + organic + Bio-fertilizer (F4)	4.26	5.40	1.18	52.67
Organic + mineral fertilizers as a foliar application (F5)	4.16	5.40	1.29	45.74
Bio + Organic + mineral fertilizers as a foliar application (F6)	4.20	5.36	1.27	43.13
LSD	0.13	0.34	0.15	1.29

4. Conclusions

The results in our study indicated that organic and bio-fertilizers with 50% of recommended mineral fertilizer can be used as an alternative to 100% recommended mineral fertilizers for increasing the growth, productivity and quality of strawberry plant. Organic and bio-fertilizer types Provide soil with essential mineral elements for plant growth as well as the promotion substance that enhanced plant growth

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