RESPONSE OF SWEET PEPPER CROP TO ORGANIC AND BIOFERTILIZER APPLICATION

BY
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ABSTRACT

" RESPONSE OF SWEET PEPPER CROP TO ORGANIC AND BIOFERTILIZER APPLICATION "

Two field experiments were carried out on sweet pepper *Capsicum annuum L.* cv. California Wonder at the Experimental Farm of the Faculty of Agriculture, Moshtohor, during the summer seasons of 2000 and 2001. The first experiment dealt with the effect of inoculating sweet pepper seeds and transplant roots with a single or mixed biofertilizer; Nitrobin and/or Phosphorin in addition to the 0, 25, 50, 75% of the required N and/or P fertilizer level. Results showed that the most favorable treatment was that inoculated with Nitrobin + Phosphorin and fertilized with 75% of the required N and P level; 60 kg N + 48 kg P_2O_5 + 96 kg K_2O, which gave the highest growth, yield and fruit quality of sweet pepper in both seasons.

The second experiment studied the response of sweet pepper plants to 4-organic fertilizer sources (Biogas, FYM, Agrolig and Chicken manure) within 4-methods of N-application. Results showed that plants which received 30 kg N as Biogas + 30 kg N in its mineral form + 64 kg P_2O_5 + 96 kg K_2O , gave the best growth, yield and fruit quality as a general trend in both seasons.

CONTENTS

1. INTRODUCTION

Farmers try to increase yields of vegetable crops by mean of heavy nutritions. The use of chemical nitrogen and phosphorus fertilizers at high levels had an adverse effect on the accumulation of NH_4^+ , NO_3^- , NO_2^- and PO_4^{--} in fruit tissues. Therefore, clean agriculture recently depends upon using organic and biofertilizers in order to produce high yields with the best fruit quality without contamination and less accumulation with heavy metals.

Biofertilizer applications depends on inoculating seeds , soil , plant roots with free living or symbiotic microorganisms in order to increase these microorganisms in the root zone. *Rhizobium sp., Azotobacter sp.* and *Azospirillium sp.* are used for the activation of N fixation. Some kinds of fungi and actinomyces such as phosphorus dissolving bacteria (PDB) and Mycorrhiza Vesicular Arbuscular (MVA) are responsible for increasing the availability of soil phosphorus.

The mechanism of these microorganisms depends on:

1. Nitrogen fixation through free or symbiotic bacteria.
2. Production of growth promoting substances or organic acids. (El-Hadad et al. , 1986)

3. Enhancing nutrient uptake or protection against plant pathogens. (Sarig et al., 1984)

The first experiment was carried out to investigate the effect of inoculating sweet pepper seeds and transplant roots with Nitrobin (contains N-free living bacteria ; *Azotobacter* and *Azospirillium*) and Phosphorin (contains a PDB such *Bacillus*) in order to decreased the needed N and P fertilizers required for growing and producing sweet peppers under clay loam soil conditions.

Organic fertilizers provide soil with essential nutrients such as N, P, S and some micronutrients after its minerilization under soil conditions (Follett et al. , 1981). Organic matter (humus) also improves soil texture, and increases ion exchange capacity of soil, increase buffering capacity and adsorb essential nutrients against leaching. Organic residues release essential nutrients faster by microbial decomposition (Follett et al., 1981). Therefore we have to focus our interest on organic fertilizer application as a good source for essential elements and improving soil texture.

The importance of using organic fertilizers in vegetable production depends on the following:

1. Producing clean vegetables for export purposes and local markets.

2. Reducing the used quantities of mineral fertilizers in order to reduce soil and plant contamination and save quantities required of N and P chemical fertilizers.

3. Producing highest yield with best quality by using less chemical fertilizers and moderate quantity of organic fertilizers.

Therefore, the second experiment aimed to study the effect of different organic fertilizer sources (FYM, Chichen manure, Biogas manure and Agrolig). in order to determine the optimum organic level and source required for clean sweet pepper production .i.e the highest fruit yield with least contamination.

2. REVIEW OF LITERATURE

The available review on the effect of bio and organic fertilizer applications on solanaceous crops such as sweet pepper and tomato as well as other vegetable crops should be discussed under the following headings:

<u>2.1. Effect of biofertilizers application on :</u>

1.1. Plant vegetative growth .

1.2. Chemical composition of plant foliage .

1.3. Flowering status of plants .

1.4. Early and total fruit yield and its components .

1.5. Fruit physical and chemical characteristics .

<u>2.2. Effect of organic fertilizers application on :</u>

2.1. Plant vegetative growth .

2.2. Chemical composition of plant foliage .

2.3. Early and total fruit yield and its components .

2.4. Fruit physical and chemical characteristics .

2.1. Effect of biofertilizers application :

Microorganisms such as bacteria , fungi and actenomyces play a principle role in N fixation and P availability in soil which may increase the uptake of N and P through plant roots. These microorganisms could be grown under laboratory conditions and then applied to seeds , roots or directly to the soil . The aim of using N-biofertilizers is to increase soil content of free living bacteria such as ; *Azotobacter sp. , Azospirillum sp. , Klebsiella sp.* and others which are expected to increase N- fixation in the soil . Of course symbiotic bacteria of genus *Rhizobium* is also considered as a good way of N- fixation in legume crops .

Fortunately, Phosphate solublizing bacteria plays a fundamental role in correcting the solubility problem in many soils by transforming this insoluble part again to be soluble. Egyptian investigators Ali *et al.* (1987) who studied extensively this process, pointed out to its importance in supplying growing plants with available phosphorus.

Several soil bacteria, particularly those belonging to the genera *Pseudomonas* and *Bacillus*, and fungi belonging to the genera *Penicillium* and *Aspergillus* possess the ability to bring insoluble phosphates in soil into soluble forms by secreting organic acids such as formic, acetic, propionic and succinic acids. These acids lower the pH and bring about the dissolution of bond forms of phosphate and render them available for growing plants (El-Hadad *et al.* 1986).

From review of literature, it is worth to mention that the response of plants to biofertilizers depends greatly on ;

1- The genus and species of the used microorganism responsible for N fixation such as; *Azotobacter, Azospirillum* , *Klebsiella* and its species . The microorganisms responsible for P-availability such as P-dissolving bacteria *(Bacillus sp.)* and fungi such Mycorrhiza . Also using single or mixed genus of these microorganisms for inoculation had a considerable effect on N or P uptake .

2- The inoculation method used for adding bacteria or fungi ; seeds inoculation, treating roots of seedlings and transplants or inoculating soil directly.

3- The rate of organic and chemical fertilizers applied to soils or plants treated with biofertilizers especially NPK levels .

2.1.1. Effect of biofertilizers application on plant vegetative growth :

Many investigators tried to use the biofertilizers containing free living bacteria in order to increase N content of the soil and consequently N uptake by plants to improve vegetative growth parameters . They referred the role of non-symbiotic N-fixing bacteria to the production of phytohormones and/or improving the availability and acquisition of nutrients which promoted the vegetative growth of treated plants. Jain and Patriquin (1985) found that bacteria of the genera, *Azotobacter* and *Azospirillum*, could produce more than 30 mg of indole acetic acid (IAA). Also, Barakat and Gabr (1998) on tomato plants indicated that *Azotobacter* and *Azospirillum* strains produced adequate amounts of IAA and cytokinins, which increased the surface area per unit root length and were responsible for root hair branching with an eventual increase in acquisition of nutrients from the soil.

2.1.1.A) Effect of N-biofertilizers application on plant vegetative growth :

With respect to the effect of N – biofertilizers on plant height ; Monib et al . (1990) found that inoculation of tomato plant seeds with *Azospirillum brasilense* and *Azotobacter choococcum* resulted a significant increase in plant height compared to the control . Paramaguru and Natarajan (1993) trials on *Capsicum* grown in a clay loam soil under semi arid conditions , *Azospirillum* applied as seed inoculation and soil application combined with 56 kg N / ha increased plants height than the contol treatment when no bacterial treatment was added.

According to number of branches and weight of shoots as affected by N– biofertilizers ; Paramaguru and Natarajan (1993) mentiond that treating *Capsicum* seeds and soil with *Azospirillum* combined with 56 kg N / ha increased plant growth expressed as number and weight of branches as compared with the control without bacterial treatment . Furthermore , Abbass and Okon (1993) found that treating seedling hypocotyls of tomato with cultures of *Azotobacter paspali* changed plant growth and development and significantly increased weight of shoot . Terry *et al.* (1996) trials on tomato grown on a compacted red ferrallitic soil of high – medium fertility received the biofertilizer *Azotobacter lipoferm* at 30 litres / ha 24 h after sowing . Results demonstrated a positive effect of *Azotobacter Lipoferm* on tomato plant growth . Other study by Barakat and

Gabr (1998) on tomato grown in sandy soil to investigate the influence of inoculation with free living N–fixing bacteria of the genera ; *Azotobacter sp.* , *Azospirillum sp.* and *Klebsiella sp.* added alone as single or together as mixed biofertilizers .They also studied the influence of inoculation with these single or mixed biofertilizer in combination with four N– fertilizer levels ; 0 , 50 , 100 and 150 kg N / fed , on tomato plant growth . Results revealed that tomato seedlings growth was greatly improved by inoculation with the single or mixed biofertilizer and the latter exerted the distinct influence . Increasing N application rate up to 100 kg N / fed or inoculation either with the single or mixed biofertilizer resulted in heavier shoot dry weight.

Concerning with plant growth expressed as fresh and dry weight; Gomaa (1989) working on tomato plants inoculated with *Azospirillum brasilense* and *Azotobacter chroococcum* in presence of two levels of NPK ; 33 kg N + 20 kg P_2O_5 + 16 kg K_2O and 100 kg N + 60 kg P_2O_5+ 48 kg K_2O or without biofertilizers . Results showed that, dry weight of plants increased with adding biofertilizers plus 33 kg N + 20 kg P_2O_5 + 16 kg K_2O as compared with the other treatments .

El–Shanshoury *et al.* (1989) mentioned that soil inoculation with *Azotobacter chroococcum* singificantly increased fresh and dry weight of tomato plants . Monib et al . (1990) and Sorial *et al.* (1992) found that , seeds or roots inoculation of tomato plants with *Azospirillum brasilense* and *Azotobacter chroococcum* resulted a significant increase in plant dry weight compared to the non inoculated control .

2.1.1.B) Effect of P– biofertilizers on plant vegetative growth:

Radwan (1983) and Saber and Gomaa (1995) on tomato, studied the effect of seeds inoculation with phosphate dissolving bacteria (PDB) on vegetative growth of plants. They indicated that plant height , fresh and dry weight were increased by using (PDB) . Hewedy (1999) found under normal levels of NPK (120 : 45 : 90) that inoculation with phosphorin (PDB) promoted leaves and branches development which led to a high fresh and dry weight of tomato leaves and branches.

2.1.1.C) Effect of adding N and P biofertilizers , on plant vegetative growth:

Moustafa and Omar (1993) studied the effect of inoculation with *Azospirillum brasilense* (N- fixing bacteria) and *Bacillus polymaxa* (P-dissoliving bacteria) on two commercial tomato varieties ; Castle rock and UC 97- 3 . Inoculation with *Bacillus polymaxa* increased plant height , fresh and dry weight of plants than plants treated with *Azospirillum brasilense* and the uninoculated control. Moreover , Saber (1993) found that inoculating tomato seeds with microbin (a mixture of nitrogen fixing bacteria and phosphate dissolving bacteria) increased vegetative growth; fresh and dry weight and plant height of plants compared with the control. Gomaa (1995) mentioned that seeds inoculation of tomato plants with a mixture of *Azotobacter chroococcum* , *Azospirillum brasilense* and *Bacillus subtilus* resulted an increase in fresh and dry weight of plants over inoculating plants with *Azospirillum brasilense* or *Azotobacter chroococcum* alone. Murumkar and Patil (1996) studied the effect of vesicular arbuscular mycorrhizal (VAM) fungi and its combination with diazotrophs *Azotobacter chroococcum* , *Azospirillum lipoferum* on *Capsicum annuum* cv. California Wonder . They found that plant dry weight significantly increased by mycorrhizal inoculation together with different diazotrophs. Recently , Ouda (2000) found that tomato plants received 75 % of the recommended NPK mixture plus 1 kg Phosphorin + 1 kg Microbin + 1 kg Rhizobacterin /fed. were similar to those received 100 % of recommended chemical fertilizers in plant height , number of leaves and branches per plant and leaf area. Tantawy (2000) studied the effect of mineral fertilizers (N and P) and some biofertilizers on the growth characters of tomato in clay soil . Results showed that using NP fertilizer at half level ; 50 kg N + 30 kg P_2O_5 with Microbin or Microbin + Phosphorin gave the best growth of stem length , fresh and dry weight of the whole plant . Furthermore the using of Microbin alone , exceeded using a mixture of Microbin + Phosphorin or Rhizobacterin + Phosphorin in respect of stem length , fresh and dry weight of whole plants .

2.1.2. Effect of biofertilizer on chemical composition of plant foliage.

2.1.2.A) Effect of nitrogen fixing bacteria on chemical content of plant foliage :

Mohandas (1987) mentioned that , inoculating tomato plants with *Azotobacter vinelandii* resulted a significant increase in N-content of plants as compared with the control . Also, Gomaa (1989) showed that , inoculating tomato seeds with *Azotobacter chroococcum and Azospirillum brasilense* resulted an increase in N and P content of plant leaves . Also, El - Shanshoury et al (1989) indicated that , N and K content of tomato plants were increased by using *Azotobacter chroococcum* . Similarly, Monib et al . (1990) and Sorial et al . (1992) found that, N and P content of tomato plants were increased with seeds inoculation by *Azospirillum brasilense* and *Azotobacter chroococcum* . Barakat and Gabr (1998) inoculated tomato plants with non- symbiotic N-fixing bacteria of the genera ; *Azotobacter sp.* , *Azospirillum sp.* and *Klebsiella sp.* alone (single biofertilizers) or together (mixed biofertilizer) or in combination with four N fertilizer levels ; 0, 50,100 and 150 Kg N / fed . Results showed a significant increase in N content and leaf chlorophyll of plants with increasing N applied rate up to 100 kg N / fed. or inoculation either with the single or mixed biofertilizer . Tantawy (2000) recorded an increase in nitrogen content of tomato plants due to inoculation with Rhizobacterin compared with unioculation under all nitrogen levels ; 0 , 50 or 100 kg N / fed .

<u>2.1.2.B) Effect of phosphate dissolving bacteria (PDB) :</u>

Radwan (1983) studied the effect of tomato seeds inoculation with PDB . He showed that , P- content of tomato plants was increased . The same result was found by (Abd-El – Moneim *et al.* , 1988 , Hewedy 1999 and Tantawy , 2000) all working on tomato inoculated with PDB .

2.1.2.C) Effect of mixture of nitrogen fixing bacteria and phosphate dissolving bacteria :

Gomaa (1995) using a mixture of six genera ; *Azospirillum* + *Azotobacter* + *Bacillus* + *Candida* + *Klebsiella* + *Pseudomonas* , exerted tremendous increase in nitrogen content of tomato plants by 192% , as compared with untreated control , under the same conditions of N – free nutrient fertilization. Gomaa (1989) also on tomato found that seed inoculation with a mixture of *Azospirillum brasilense* , *Azotobacter chroococcum* and phosphate dissolving bacteria resulted a significant increase in N and P contents over *Azospirillum brasilense* or *Azotobacter chroococcum* alone. Poi (1998) found that inoculating the soil with *Azospirillum* and *Pseudomonas* amended the soil characters and increased the available N and P in the soil and its uptake by chilli and tomato plants than untreated ones . Furthermore , Ouda (2000) found that a mixture of 1 kg Phosphorin + 1 kg Microbin + 1 kg Rhizobacterin per feddan increased NPK content of tomato plant foliage and gave similar influnce to 75 % of recommended mineral NPK fertilizers . Tantawy (2000) found that , the maximum values of nitogen and phosphorus were more distinct via using Microbin + Phosphorin treatment , which came in the first rank , followed by the treatments of Microbin or Phosphorin alon and Rhizobacterin + Phosphorin . However , potassium content of tomato plants was not affected by using any biofertilizer treatments .

2.1.3. Effect of biofertilizer application on plant flowering .

It is well known that N application in mineral and organic fertilizers plays an important role on plant vegetative growth , C/N ratio in plant leaves , flowering and fruit setting as well as early and total fruit yield . Few review is available on the effect of biofertilizers on flowering of solanaceous crops . Martinez *et al.* (1994) found that soil inoculation with *Azotobacter chroococcum* increased the number of flowers per plant in tomatoes and reduced flower drop which resulted in earlier flowering . Barkat and Gabr (1998) studied on tomato flowering as affected by inoculation of tomato plants with non-symbiotic N-fixing bacteria of the genera ; *Azotobacter sp.* , *Azospirillum sp.* , and *Klebsiell sp.* alone (single biofertilizers) or together (mixed biofertilizer) or in combination with four N fertilizer levels ; 0 , 50 , 100 and 150 kg N / fed . They found that the number of clusters per plant and number of flowers per cluster were increased with increasing N applied rate up to 100 Kg N per feddan when inoculated either with single or mixed biofertilize. Hewedy (1999) reported that the fruit set percentage and number of clusters per tomato plant were increased when supplied with normal levels of NPK (120:45:90) and inoculated with phosphorin (PDB) .

2.1.4. Effect of biofertilizers application on fruit early, total yield and its components :

Many investigators mentioned a positive response on fruit yield of solanaceous crops by inoculating soil or seeds with nitrogen free living bacteria . This increment in fruit yield depended on the genus and species of used bacteria *;* *Azotobacter sp.* , *Azospirillum sp.* , and *Kelebsilla sp.* , and it varies also due to the crops itself , the growing season and the inoculation method as well as soil conditions.

2.1.4.A) Effect of nitrogen fixing bacteria :

Jackson *et al.* (1964) reported that inoculation of tomato plants with *Azotobacter chroococcum* significantly increased fruit yield than the untreated control . Mehorta and Lehri , (1971) on eggplant revealed a positive effect on fruit yeild by using *Azotobacter chroococcum* . This increase in eggplant yield ranged from 15 to 62 % . Shahaby (1981) studied the response of tomato plants to inoculation with *Azospirillum brasilense* under field condition . There was no significant effect on the tomato yield in winter season while , in summer season fruit yield per plant was increased by 9.2 % in inoculated plants over the control . Antipchuk *et al.* (1982) reported that , inoculating soil with different *Azotobacter* strains resulted an increase in tomato yield . Mohandas (1987) mentioned that , inoculation of tomato plants with *Azotobacter vinelandii* significatly increased fruit yield . Bashan and Singh (1989) found that , inoculation of tomato plants with *Azospirillum brasilense* caused an increase in the yield by 23 % . Bashan et al . (1989) also mentioned that , inoculation of sweet pepper with *Azospirillum brasilense* resulted in significant increase in fruit yield by 18 % . Kumaraswany and Madalageri (1990) studied effect of dipping tomato seedling roots in a suspention prepared by mixing 2 kg of *Azotobacter chroococcum* with 10 litres water . Nitrogen was applied at 3-levels , the recommended level (60 kg / ha) , half of N (30 kg / ha) and 30 kg / ha of N + *Azotobacter* . The biofertilizer treatment (30 kg N / ha + *Azotobacter*) produced higher yield (48.1 ton / ha) and better fruit quality as compared with using the recommended dose of nitrogen with no bacterial treatment . Moustafa and Omar (1990) studied the effect of inoculating tomato plants with *Azospirillum lipoferum* . They found that , yield was increased by 22.1 to 33 % over the control . Gomaa (1995) found that , inoculation with mixture of *Azospirillum brasilense* and *Azotobacter chroococcum* caused an increase in tomato yield by (21.4 %) . Hameedunnisa and Begum (1998) trails on tomato seeds or seedlings treated with *Azotobacter sp* . and fertilized with 0 , 50 , 150 and 200 kg N / ha . They found that inoculating tomato seeds with *Azotobacter sp*. and application with 150 kg N / ha gave the highest yield than the control treatment i.e without N application or *Azotobacter* inoculation. Moreover , dipping tomato seedlings in *Azotobacter* suspension increased fruit yield than the control, with no *Azotobacter* treatment. Barakat and Gabr (1998) studied the effect of inoculating tomato plants with non-symbiotic N-fixing bacteria of the genera ; *Azotobacter sp. , Azospirillum sp.* and *Klebsiella sp.* , alone or together or in combination with four N fertilizer levels ; 0 , 50 , 100 and 150 kg N / fed. on tomato fruit yield . They showed that number and weight of fruits per plant , and total yield were increased with increasing N applied rate up to 100 kg N / fed. or inoculation either with the single or mixed biofertilizer. Tantawy (2000) mentioned that inoculating tomato seeds with Rhizobacterin + appling 50 % of nitrogen fertilizer , increased total yield of tomato by 30.6 % than the untreated control and gave the maximum increase of average fruit weight , early and total yield .

On the other hand, Terry *et al.* (1995) and (1996) found that inoculating tomato seeds with *Azospirillum brasilense* + 30 kg N/ha applied in seed beds in the nusery + 45 kg N/ha just after transplanting resulted a slight increase (but not significant) in fruit yield compared to 23.16 ton / ha produced from the standard-practice treatment which consisted of *Azotobacter chroococcum* + 30 kg N / ha applied at the seedbed + 45 kg N / ha at transplanting + 45 kg N / ha a month after transplanting . They also found that using *Azospirillum* , instead of *Azotobacter* achieved similar yield with saving of 45 kg N / ha.

2.1.4.B) Effect of phosphate dissolving bacteria (PDB) :

Abd-El-Moneim *et al.* (1988) studies on tomato cvs UC 97-3 and Peto 86 showed that inoculation with PDB increased early and total yield . This effect was more pronounced under low level of (P) fertilization up to 30 kg P_2O_5 / fed . Hewedy (1999) found, under normal levels of NPK (120:45:90) , that inoculation of tomato plants with Phosphorin (PDB) increased number of fruits per cluster and average fruit weight .

On the other hand , Tantawy (2000) found that , in spite of recording promotion in early and total yield of tomatoes by 41.6 % and 18.3 % respectively , due to using Phosphorin (PDB) ; these increments were not significant . However , Phosphorin (PDB) treatment produced heavier fruit weight over the untreated plants .

2.1.4.C) Effect of nitrogen fixing bacteria and phosphate dissolving bacteria :

Many investigators proved that inoculation plants, with a mixture of *Azospirillum* and phosphate dissolving bacteria (PDB) exerted more pronounced effect on yields of such plants as compared to the individual use of each bacteria (Karuthamani *et al.* ,1995) i.e inoculating plants with *Azospirillum* alone or PDB alone.

Gomaa (1989) found that , inoculation of tomato plants with a mixture of *Azotobacter chroococcum* , *Azospirillum brasilense* and phosphate dissolving bacteria (PDB) caused an increase in total yield over inoculation with *Azotobacter chroococcum or Azospirillum brasilense* alone . Ouda (2000) found that inoculating tomato seedlings with a mixture of 1 kg Phosphorin + 1 kg Microbin + 1 kg Rhizobacterin + 75 % of recommended NPK chemical fertilizer per feddan gave relatively higher early yield than that obtained from using 100 % of recommended chemical fertilizer / fed. Tantawy (2000) observed that maximum increment of both average fruit weight and total yield were obtained via using Rhizobacterin treatment which came in the first rank , followed by Microbin , Rhizobacterin + Phosphorin treatments which came in the second rank . Control treatment , which received the same levels of NPK , without any bacterial inoculation produced the lowest early and total yield . Moreover , plants received NP fertilizer at 50 kg N + 30 kg P_2O_5 with Microbin or Rhizobacterin + Phosphorin gave the maximum higher total yield .

2.1.5. Effect of biofertilizer on fruit quality.

With respect to the effect of nitrogen fixing bacteria on fruit quality , Jackson et al . (1964) reported that , inoculation of tomato plants with *Azotobacter chroococcum* improved fruit weight . Also Moustafa and Omar (1990) mentioned that tomato inoculation with *Azospirillum lipoferum* increased fruit weight . While total soluble solids was not affected by inoculation . On the other hand , Kumaraswany and Madalageri (1990) found that , inoculation of tomato with *Azotobacter chroococcum* and applying 30 kg N / ha. , gave the best quality of fruits . Barakat and Gabr (1998) found that , weight of fruits was increased by inoculating tomato plants with *Azospirillum* and *Azotobacter* .

Regarding the effect of phosphate dissolving bacteria (PDB), Abd-El-Moneim *et al.* (1988) mentioned that , inoculation of tomato plants with phosphate dissolving bacteria resulted significantly higher fruit weight compared to the non inoculated ones .

Regarding to the effect of mixture of nitrogen fixing bacteria and phosphate dissolving bacteria , Tantawy (2000) found that , all biofertilizer treatments (nitrogen fixing bacteria alone or phosphate dissolving bacteria alone or together) caused a significant increase in TSS of tomato fruits . The highest value of TSS was obtained by using NP fertilizer at 50 kg N + 30 kg P_2O_5 /fed. with Rhizobacterin + Phosphorin treatment .

2.2.Effect of organic fertilizer application :

Organic fertilizers such as FYM, Biogas, Chiken manure, Compost, Pigeon and Green manure are a good sources for macro and micronutrients essential for plant growth. It is also a good soil conditioner for both sandy and heavy clay soils (Tisdale and Nelson,1975). Organic matter increases the porosity of heavy soils, which in turn increases water absorption and lessens water run-off, leaching, and erosion (Ware and Mc-

Collum,1980). The increased porosity also causes greater aeration, which favors the right kind of bacteria for nutrient liberation and direct chemical oxidation processes. On the other hand, organic matter will help to keep sandy soils from becoming too porous. The black color imparted by organic matter causes heat absorption, aiding the soil to warm up quickly, provided that the amount of water present is not excessive.The response of plant growth, yield and fruit quality to organic fertilizers application greatly dependes on the time, source, age and level of applied organic fertilizer as well as the other applied chemical fertilizers. It is also mentioned that soil texture, soil pH, soil aeration, soil moisture and crop itself are greatly affected by organic fertilizer application, (El-Shimi, 1998).

2.2.1.Effect of organic fertilizer application on vegetative growth :

Chindo and Khan (1986) observed that, tomato plant growth was increased with increasing the level of poultry manure application up to 8 ton/ha. Brechelt (1989) revealed that, stable manure and compost applied at 5, 10, 20 or 30 tons/ha to *Capsicum* grown in greenhouse stimulated plant growth up to 20 tons/ha, but generally fell with increasing rates of application from 20 upto 30 tons/ha. Abo-El-Defan (1990) reported that, addition of chicken manure at 373.7g/100 kg soil increased the fresh and dry weight of tomato shoots which grown under geenhouse condition. Gianquinto and Borin (1990) observed that, manure fertilizer application encouraged tomato plant growth, and the fastest growth was obtained with FYM at 20 ton/ha combined with 100 kg N + 50 kg P_2O_5 + 140 kg K_2O /ha. Corrales *et al.*, (1991) studies on two sources of organic fertilizer at the rate of 4 ton/ha, i.e, decomposted chicken manure and compost made of sugar-cane bagasse, sawdust and aches at 2:1:1. They found that, leaf area of pepper plants was significantly increased by incorporating both materials into the plant bed. Shehata (1992) reported that the application of farm yard manure as organic manure significantly increased the dry matter content of sweet pepper plant leaves at both plant stages of 70 and 100 days after transplanting . Whereas, a steady significant increase in dry matter content were recorded with increasing the rate of FYM from 25, 50, 75 up to 100 m^3 / fed. Midan (1995) noticed that, adding organic manure at 25 or 50 m^3 / fed as FYM with chemical fertilizers at 60 or 120 kg N/fed. generally gave superior plant height, with large number of leaves and branches which increased dry weight of different plant organs and leaf area. However, this effect, was varied and depended on different growth stages and variation of pepper genotypes. Lulakis and Petsas (1995) found that humic substances (humic acids, fulvic acids and sodium humate solution) were beneficial to shoot growth at concentrations of 1000-2000 ppm. Shoot growth was promoted more than root growth by humic substances. Eissa (1996) studies on sweet pepper supplied with different sources of organic manure; pigeon, chicken or cattle at rate of 20 kg of each organic manure/ 9m line length, increased the plant growth charactaristics, expressed as fresh, dry weight of shoots, plant height, stem diameter and number of leaves per plant . The highest growth was fluctuated between the pigeon and chicken manure application at rate of 20 kg/9m line length. Abd-El-Aty (1997) studies on sweet pepper plants grown under polyethylene tunnel and supplied with cattle, pigeon, chicken manure and town refuse at 3-levels of each; 2, 4 or 6 m^3 /house (540 m^2) combined with or without addition of chemical fertilizers. Results showed that, addition of pigeon or chicken manure increased plant vegetative growth; plant height, number of leaves, total leaf area, chlorophyll content, fresh and dry weight of whole plant and its organs. All vegetative growth parameters were increased with increasing the level of organic manure (from 2 up to 6 m^3/house). Also, addition of organic manure combined with chemical fertilizers reflected a slight superiority on plant growth. Mikhaeel,*et al.*(1997) found that *Glomus aggregatum* and biogas manure in combination gave maximum shoot and root dry weight of tomato under greenhous conditions. A green house experiment by Asmos and Andrade (1998) on tomato supplied with chicken manure at 15 and 30%,V/V improved plant growth.

2.2.2.Effect of organic fertilizer application on chemical composition of plant foliage:

Many investigators mentioned the favourable role of organic fertilizers application on chemical constituents of plant foliage. This effect on N,P,K and heavy metals uptake and its accumulation in plant tissue depends upon, the source and level of organic fertilizer as well as the fertilized crop itself. Abd-El-Maksoud *et al.*, (1975a) noticed that, concentrations of NPK in the whole pepper plant tissues favourably affected by stable manure application at 30 m^3/fed. Williams (1977) reported that, heavy metals (Zn, Cu and Ni) present in sewage and sludge, are most likely to be toxic to plants. Other metals such as Cd, Pb or Hg may also be present but their concentrations in sewage and sludge are not normally high enough to have any adverse effect on plant growth. Abo-El-Defan (1990) revealed that, the addition of chicken manure at 373.7g/100 kg soil increased the concentrations and uptake of N, P, K in tomato shoots . Montagu and Goh (1990) reported that, N concentration increased in tomato foliage with increasing rates of organic matter used in tomato fertilization. Fattahallah (1992a) found that, the concentrations of N, P and K in tomato leaves were increased with increasing the amount of FYM up to 40 m^3/fed. Shehata (1992) reported that, NPK content of sweet pepper leaves increased with increasing FYM rates from 25 up to 100 m^3 / fed. Midan (1995) on field trials reported that, the highest levels of farm yard manure (50 m^3/fed) and nitrogenous fertilizers (120kg N/fed) generally exerted the highest content of N, P and K in pepper tissues. Eissa (1996) revealed that, NPK nutrients and heavy metals (Ni, Cd and Pb) concentrations and their uptake increased in leaves of pepper plants with the application of different animal manure sources, i.e pigeon, chicken and cattle. Moreover, the same author added that, the highest values of nutrients concentration and uptake were associated with the addition of chicken or pigeon manure at 20 kg/9m lines length. Abd-El-Aty (1997) studied the effect of 4-organic fertilizer sources; cattle, pigeon, chicken manures and town refuse at 3-levels of each; 2, 4 or 6 m^3 /house (540 m^2) combined with or without addition of chemical fertilizers on pepper plants. Results showed that, the addition of pigeon or chicken manures increased N,P, and K content of leaves. The concentrations of heavy metals in leaves increased due to the application of town refuse,but it did not exceed the permissible limits. All measured nutrients uptake characters were increased with increasing the level of organic manure (from 2 up to 6 m^3/house). Also, addition of organic manure combined with chemical fertilizers reflected a slight superiority in all previous characters. Siminis *et al.*(1998) found that, tomato plants grown in hydroponics under greenhouse and supplied weekly with humic substances (HS) at 5 or 50 mg/litre. They reported that total-N content was 10 and 12% higher in leaves from plants exposed to HS at 5 and 50 mg/litre, respectively. On the other hand, Matev (1974) reported that, no marked differences in N,P and K content in plant tissues of tomato were found in plants supplied with 100 tons FYM/ha. As compared with the control.

2.2.3.Effect of organic fertilizer application on fruit yield and its components:

Subbiah *et al.*,(1982) studied the effect of FYM on sweet pepper at a rate of 25 tons/ha. as basal dressing plus 40-120 kg N/ha. + 35 kg P_2O_5/ha. The highest yield was obtained from plants received FYM + the highest N rate .

Silva *et al.*,(1989) studies on tomato crop received 30-180 kg N/ha., 75-450 kg P_2O_5/ha. and 30-180 kg K_2O/ha. + chicken manure at 0-20 ton/ha. The highest fruit yield was obtained when the plants fertilized with N, P and K at 60, 150 and 60 kg/ha. + chicken manure at 20 tons/ha. The lowest yield was obtained with NPK 120:0:120 kg/ha. Pudelski (1988) mentioned that, the higher commercial yields of *Capsicum* were generally obtained on the substrate consisting 10% chicken manure. Piven *et al.*, (1989) indicated that, the fertilization with FYM, had a substantial positive effect on yield of cucumber and tomato plants. Prezotti *et al.*, (1989) found that, application of poultry manure at 10 tons/ha increased the total productivity of tomatoes. Hilman and Suwandi (1989) found that, sheep, horse and cow manure were each applied at 10, 20, 30 or 40 tons/ha. to a tomato crop. The highest yield was obtained with sheep manure at 30 tons/ha. Silva and Vizzotto (1989) noticed that, the highest yield of good quality of tomato fruits (53 tons/ha) was obtained with 103.5 kg N + 258.8 kg P_2O_5 + 20 tons poultry manure/ha. but the yield declined to 46.2 tons/ha without poultry manure application. Surlekov and Rankov (1989) revealed that, the application of NPK at 100, 80 and 100 kg + 20 tons FYM/ha produced the highest average yield of tomato as compared with that of lower fertilizer levels . This yield was 73.4% above the unfertilized control. Gianquinto and Borin (1990) reported that, manure fertilizer application increased tomato fruit yield but the effects were moderated by soil type. Whereas, in the clay and sandy soils the higher yield was obtained with FYM at 20 tons/ha combined with 100 kg N + 50 kg P_2O_5 + 140 kg K_2O/ha. Singh (1989) studies on the national biogas sludge manure in India reported that crop yields increased and the best results (70%) were in vegetable crops such as tomato.Gianquinto and Borin (1990) trials on tomato grown in sandy , clay or peaty clay soil and given (a) 20 or (b) 40 ton FYM/ha., (c) 100 kg N + 50 kg P_2O_5 + 140 kg K_2O , (d) 200 kg N + 100 kg P_2O_5 + 280 kg K_2O , (e) treatment (a) and (c) combined fertilizer . They found that , manure application increased tomato fruit. Abo-EI-Defan

(1990) studies under green house conditions found that, addition of organic fertilizer as chicken manure at 373.7g/100 kg soil, increased fresh and dry yield of tomato fruits. Corrales *et al.*, (1991) revealed that, yield of pepper plants were significantly increased by incorporating chicken manure or compost into the plant bed at rate of 4 tons/ha. Maynard (1991) reported that, the yield of pepper, tomato, eggplant with poultry manure at 50 tons/acre were equal to or greater than those obtained with inorganic fertilizers . Ranganna *et al.* (1991) a trials on tomato and chili observed that using biogas spent sludge (BGSS) gave the greatest yield in comparison with using FYM at rate of 10 tons/ha. They referred the yield increase to the higher content of NPK in (BGSS) fertilizer than FYM. Fattahallah (1992b) noticed that, increasing the amount of farm yard manure up to 40 m^3/fed increased the yield of tomato fruits and its components. Omran *et al.*(1995) studies on sweet pepper cv. California Wonder grown under green house experiments fertilized with (FYM) at 0, 25, 75 or 100 m^3/fed. Raising the FYM rates significantly increased the number and weight of fruits which increased crop yield. Midan (1995) noticed that, the farm yard manure at 25 or 50 m^3 /fed. augmented the pepper fruit yield and its components. Eissa (1996) showed that, application of different animal manures, i.e. pigeon, chicken or cattle at 20 kg of each/9m lines length increased fruit yield of sweet peppers. Whereas, chicken or pigeon manure recorded the highest yield values. Abd-El-Aty (1997) studies on the effect of 4-organic fertilizer sources; cattle, pigeon, chicken manures and town refuse at 3-levels of each; 2, 4 or 6 m^3 /house (540 m^2) combined with or without addition of chemical fertilizers on pepper plants. Results showed that, the addition of pigeon or chicken manures gave the highest early yield and total yield. Also, the fruit yield increased with increasing the level of organic manure from 2 up to 6 m^3/house. Furthermore, the addition of organic manure combined with chemical fertilizers gaves the best yield than other treatments. Patil *et al.* (1998) studies on tomato plants fertilized with farmyard manure, vermicompost or inorganic fertilizers, singly or in various combinations. They found that the highest yield and net income were realized with the recommended rate of inorganic fertilizer (NPK at 100, 75 and 100 kg/ha.) + vermicompost at 2 tons/ha. Vermicompost at 4 tons/ha. + 50% of the recommended inorganic fertilizer rates gave similarly good results. Siminis *et al.*(1998) studies on tomato plants grown in hydroponics under green house and supplied weekly with humic substances (HS, extracted from composted leaves of olive trees) at 5 or 50 mg/litre. Total fruit yield of plants treated with 5 and 50 mg/litre HS was 5 and 10% higher than the control. Segura *et al.*(1999) trials on tomatoes and capsicum grown under plastic green houses in sandy soil were supplied with farmyard manure or a mixture of commercial manures (Italpollina + Phenix) composed of poultry manure, guano and concentrated vinasse. Capsicum plants were supplied with 60 tons FYM manure/ha. or 2.5 tons italpollina/ha. + 1.5 tons phenix/ha. Commercial manure application increased final total marketable yield in *Capsicum*.

On the other hand, Abd-El-Maksoud *et al.*, (1975a) studies on sweet pepper grown in winter under open field condition found that, number of fruits per plant was slightly affected by

FYM organic manure application. Stable manure at 30 m3/fed produced marginally the best early and total yield.

2.2.4. Effect of organic fertilizer application on fruit quality:

Abdel-Maksoud *et al.*, (1975a & b) reported that, stable manure at high level (30 m^3/fed.) improved sweet pepper fruit quality including both physical and chemical characteristics. However, slight effect on diameter, length and flesh thickness of pepper fruits was observed as a result of stable manure application at rate of 30 m^3/fed. Moreover, heavy application of stable manure (30 m^3/fed.) improved average fruit weight, fruit dry matter percentage, vitamin C content, P and K content of sweet pepper fruits. Hasegawa (1989) showed that, total sugar level and ascorbic acid content in tomato fruits were the highest with adding organic fertilizer. Moreover, organic fertilizer application gave high number of small fruits. Bagal *et al.*(1989) grow tomato in raised beds under field conditions. A basal dose of 20 tons FYM/ha. was applied and combined with 3-level of NPK; (100, 200 and 400 kg N/ha.),(50, 100 and 200 kg P_2O_5/ha.) and (50, 100 and 200 kg K_2O/ha.). They mentioned that protein, sugar, ascorbic acid, TSS, acidity and mineral content were significantly increased by increasing the rates of N,P and K. The application of 200 kg N, 100 kg P_2O_5 and 100 kg K_2O/ha. produced the best fruit quality. Abo-El-Defan (1990) observed that, the' addition of chicken manure at 373.7 g/100 kg soil, increased the concentration and uptake of N, P, Fe, Mn and Zn in tomato fruits. Silva and Vizzotto (1990) noticed that, tomato fruits were longer in plants supplied with poultry manure at 20 tons/ha. plus N, P_2O_5 and K_2O at 104, 259 and 104 kg/ha., respectively. Demirovska *et al.*, (1992) indicated that, vitamin C content in pepper fruits varied according to the rates of nitrogen fertilizer applied as mixed with the FYM at 40 tons/ha. Abd-El-Aty (1997) studies on the effect of 4-organic fertilizer sources; cattle, pigeon, chicken manures and town refuse at 3-levels of each; 2, 4 or 6 m^3 /house (540 m^2) combined with or without addition of chemical fertilizers on pepper plants. Results showed that, the addition of pigeon or chicken manures increased the length, diameter, size and weight of fruit and gave the highes fruit content of vitamin-c , acidity and TSS as well as the highest concentration of N, P and K. Also the previous parameters were increased with increasing the level of organic manure from 2 up to 6 m^3/house. Generally, the addition of organic manure combined with chemical fertilizers reflected a slight superiority in fruit quality including all previous characters.

On the other hand, Trpevski *et al.*,(1992) noticed that, different nitrogen rates combined with FYM at 40 tons/ha. generally had no significant effect on fruit N, dry matter, organic acid and vitamin C contents of tomato fruits. Midan (1995) studies on sweet pepper plants received FYM at rates of 0, 25 or 50 m^3 /fed combined with chemical N-fertilizer at rates of 0, 60 or 120 kg N/fed, revealed no significant variation in fruit dimensions, i.e., length and width, whereas, the highest levels exerted the highest value in pericarp thickness of fruit. Concerning with the chemical composition of fruits, plants received the medium levels of both FYM and chemical NPK fertilizers produced fruits contained more vitamin C and TSS but titratable acidity was not significantly affected. Moreover, no definite trend could be noticed due to the different levels of both two factors about NPK contents in fruits.

Concerning with heavy metals content of fruits as affected by source and level of organic fertilizers, Eissa (1996) reported that, adding organic manures at different sources (cattle, chicken and pigeon manures) at rate of 20kg of each one/9 meter line length increased of N, P, K, Fe, Zn, Mn, Cu and Ni % in pepper fruits. Moreover, the highest uptake values of N and P were associated with the addition of pigeon manure, while higher K uptake was associated with the addition of chicken manure. Also the highest values of Ni in pepper fruit were associated with the addition of chicken manure. Whereas, addition of organic manures increased the concentrations of heavy metals, i.e. Cd and Pb although the concentrations are still less than the critical limits permitted to be found in normal plants. Whereas, addition of pigeon manure showed the highest values of Cd and Pb concentrations.

4. RESULTS AND DISCUSSION

4.1. First experiment :

Effect of biofertilizers application on vegetative growth, chemical constituents, flowering, yield and fruit quality of sweet peppers.

4.1.1. Effect of biofertilizer treatments on vegetative growth :

Data on plant growth 70 days after transplanting (Table, 1) , shows that all biofertilizer treatments significantly increased plant growth over the control when no bio or chemical fertilizers were added . Data also show that adding a mixture of Nitrobin + Phosphorin was able to save 25 % of chemical N and P fertilizers required for plant growth . Therefore , Nitrobin + Phosphorin + 3/4 N + 3/4 P + K (treatment No.15) gave the highest values regarding plant height, stem diameter , number of leaves , leaf area as compared with all treatments , in both seasons . Concerning dry weight ; plants received mixture biofertilizer of Nitrobin + Phosphorin + 3/4 N + 3/4 P + K (treatment No. 15) also gave the highest dry weight followed by those which received the full dose of NPK without biofertilizers (treatment No. 16)or those that received Nitrobin +Phosphorin + 1/2 N + 1/2 P + K . (treatment No.14) , as showen in both seasons of 2000 and 2001 . Data on plant fresh weight (Table, 1) show that

treatments (No.4, 5, 9, 10, 14, 15 and 16) gave similar and higher fresh weight as compared with all other treatments . It means that , plants supplied with 100% NPK without biofertilizers or with 50 or 75% of the N requirments + Nitrobin or with 50 or 75% of the P requirments + Phosphorin or with 50 or 75% each of the N and P + Nitrobin + Phosphorin gave a higher fresh weight per plant compared to other treatments. Moreover, the high N-fertilizer level either in the bioform (Nitrobin) or in the chemical form $(NH_4)_2SO_4$ was associated with the high fresh weight but not with dry weight . Data also show that plants supplied with a mixed biofertilizer (Nitrobin + Phosphorin) treatment No. 11 , had better plant growth (plant height , number of leaves , leaf area , fresh and dry weight) than those which received a single biofertilizer; either Nitrobin only or Phosphorin only ; treatments No.1 and 6 , respectively . This trend was true in both seasons .

These results are in harmony with those of Bopaiah and Khader (1989) on sweet pepper, Monib et al . (1990) on tomato and Paramaguru and Natarajan (1993) on capsicum, who found that plant growth was increased by inoculation with *Azotobacter sp* . and *Azospirillum* . The Nitrobin used for inoculating seeds and seedlings grown in this study includs a mixture of free living bacteria such as *Azotobacter* and *Azospirillum* . Barakat and Gabr (1998) also indicated the favourable role of inoculating tomato seedlings with free living bacteria of *Azotobacter sp* . , *Azospirillum sp . and Klebsiella sp.* They also found that adding 100 kg N / fed . plus mixed or single biofertilizer of one or more of the three genera of the free living bacteria resulted a larger and heavier plant growth expressed as dry weight . The superiorlty of plants that received 1/2 or 3/4 N + P and K + Nitrobin (treat. No.4 and 5) was true in both seasons but only for fresh weight and not for dry weight . This result may be referred to the role of N on increasing moisture content of vegetative parts .

Many investigators mentioned the favourable role of inoculating seeds with phosphorus dissolving bacteria (PDB) on plant growth, among them Radwan (1983) and Saber and Gomaa (1995) on tomato . The increase in plant growth of sweet pepper plants supplied with Phosphorin + 3/4 P + NK is in complete agreement with the results of Hewedy (1999) on tomato using Phosphorin + NPK .

This superiority in plant growth by inoculating soil or seeds with a mixture of N-free living bacteria + Phosphorus dissolving bacteria is in agreement with the results obtained by Moustafa and Omar (1993) using *Bacillus* and *Azospirillum* , Saber (1993) using Microbin and Gomaa (1995) using *Azospirillum* , *Azotobacter* and *Bacillus* .

This high plant growth of treatment No.15 is in complete agreement with the studies of Ouda (2000) on tomato, he found that adding Phosphorin + Rizobacterin and Microbin to tomato plants which received 75% of the recommended NPK were similar to those which received 100% of the recommended chemical fertilizer. Results here indicates that we can save 25% of the required N and P fertilizer to sweet pepper plants by adding a mixed biofertilizer of Nitrobin + Phosphorin.

The role of N-free living bacteria in production of phytohormones or improving the availability and acquisition of nutrients or by both, may explain the encouraged growth of plants inoculated with these non – symbiotic N-fixing bacteria (Barakat and Gabr , 1998). Furthermore , *Azotobacter* and *Azospirillum* could produce IAA and cytokinins which increased the surface area per unit root length and were responsible for root hair branching with an eventual increase in acquisition of nutrients from the soil (Jain and Patriquim , 1985) .

Concerning plant growth 100 days after transplanting, (Table, 2) data also shows that plants which received 3/4 N + 3/4 P + K + Nitrobin + Phosphorin (treatment No.15) gave the highest plant growth , plant height and stem diameter as compared with all other treatments in the second season and leaf area , fresh and dry weight in both seasons .

Results also show that plants inoculated with a single biofertilizer; Nitrobin or Phosphorin and supplied with 0 , 25 , 50 , or 75% of the required level of N or P (treat's No. 2 , 3 , 4 , 5 or treat's No.7, 8 , 9 , 10 respectively) gave higher growth than

RESULTS AND DISCUSSION

those that received a single biofertilizer without any chemical fertilizer (treatments No. 1 and 6) .

Generally , data of plant growth indicated that adding a mixture of biofertilizers (Nitrobin + Phosphorin) can save at least 25% of N and 25% of P requirements of sweet pepper plants . Therefore , the treatment No.15 was the most favourable treatment with respect to plant growth parameters i.e. plant height , stem diameter , number of leaves , leaf area and dry weight per plant .

4.1.2. Effect of bioferilizer treatments on NPK uptake and chlorophyll content in leaves (70 days after transplanting):

Data (Tables 3&4) clearly show that the highest uptake of N, P and K accumulation in leaves, stem and total foliage 70 days after transplanting was found in plants of treatment (No.15) which was inoculated with Nitrobin and Phosphorin and fertilized with 75% of the required dose of N and P. Inoculating sweet pepper seeds and transplanting roots with Nitrobin and/or Phosphorin without adding any chemical fertilizers (treatments No.1 , 6 and 11) gave lower NPK uptake in leaves , stem and total foliage as compared with all other treatments except the control (without any bio or chemical fertilizer). This means that the biofertilizers application with Nitrobin or Phosphorin or both were able to provide plants with its full reqirement of N and P.

Generally, data show that inoculating plants with Nitrobin and/or Phosphorin significantly increased NPK uptake of plant foliage 70 days after transplanting and this increase was significant and gradual with increasing levels of N and/or P application from 25%, 50% upto 75% of each element. Therefore, the maximum NPK uptake was obtained from (treatment No.15) when plants inoculated with Nitrobin + Phosphorin and fertilized with 3/4 N +3/4 P +K in both seasons. This means that we can save 25% of the required nitrogen and phosphorus fertilizers by inoculating seeds and transplants before growing with a mixed biofertilizer (Nitrobin + Phosphorin). This trend was true in both seasons and results could be referred to the role of Nitrobin and Phosphorin on the availability of soil nitrogen and phosphorus.

On the other hand, plants supplied with N, P and K in the mineral form without any biofertilizers (treatment No.16) accumulated less N and K in leaves and stem as compared with plants supplied with a mixed biofertilizer + 3/4 N +3/4 P + K (treatment No.15). Results are confirmed with those indicated by Monib *et al.* (1990), Sorial *et al.* (1992), Gomaa (1995) on tomato , Poi (1998) on chili and tomato and Ouda (2000) on tomato who mentioned the favorable role of Nitrobin (*Azotobacter* or *Azospirillum*) and Phosphorin on both N and P uptake by plant roots.

Concerning the effect of biofertilizer treatments on chlorophyll content in leaves, (Tables, 3&4) data shows that treatments (No.5, 10, 12, 13, 14, 15 and 16) gave similar and higher chlorophyll A, treatments (No.3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15 and 16) gave similar and higher chlorophyll B. This means that plants inoculated with Nitrobin and / or Phosphorin had high chlorophyll content with respect to total chlorophyll content. Therefore, treatments No.14, 15 and 16 gave similar and higher total chlorophyll as compared with all other treatments, as shown in both seasons. Moreover, a mixed biofertilizer treatment No.11 and a single biofertilizer (treatments No.1 and 6), significantly increased chlorophyll A and total chlorophyll over the control when no bio or chemical fertilizers were added, with no significant differences in chlorophyll B as shown in both seasons.

Results are in harmony with Barakat and Gabr (1998) on tomato plants, who indicated a significant increase in leaf chlorophyll content of plants with increasing N applied rate up to 100 kg N / fed. or inoculation with either the single or mixed biofertilizer .

4.1.3. Effect of biofertilizer treatments on NPK uptake (100 days after transplanting) :

Data shown in Tables (5 and 6) and Figs. (1, 2 and 3) on NPK uptake allover the season show the same trend previously

mentioned 70 days after transplanting (Tables 3 and 4). i.e. the highest total NPK uptake was found in plants of treatment (No.15) which was inoculated with a mixture of Nitrobin and Phosphorin and fertilized with 75% of the required dose of N and P plus K. Inoculating sweet pepper seeds and transplant roots with Nitrobin and /or Phosphorin without adding any chemical fertilizers (treatments No. 1, 6 and 11) gave lower NPK uptake as compared with all other treatments except the control in which no bio or chemical fertilizers were added. This trend was true in both seasons of this work at the two sampling stages (70 days after transplanting and 100 days after transplanting). It means that the biofertilizers application neither Nitrobin nor Phosphorin or together were able to provide plants with its full requirement of N and P.

Generally, data show that inoculating plants with Nitrobin and/or Phosphorin significantly increased NPK uptake in the two stages and this increase was significant and gradual with increasing levels of N and/or P application from 25%, 50% upto 75% of each element. Therefore, the maximum NPK uptake was obtained from (treatment No.15) when plants were inoculated with Nitrobin + Phosphorin and fertilized with 3/4 N + 3/4 P + K in both seasons the two stages i.e. 70 and 100 days after transplanting. **This means that 25% of the required nitrogen and phosphorus fertilizers could be saved by inoculating seeds and transplants before growing with a mixed biofertilizer consisted of Nitrobin + Phosphorin. This trend**

was true in both seasons and results could be referred to the role of Nitrobin and Phosphorin on increasing the availability of both N and P in the soil.

On the other hand, plants supplied with NPK in the mineral form without any biofertilizers (treatment No.16) accumulated less NK uptake 70 days after transplanting and less NPK uptake 100 days after transplanting as compared with plants supplied with a mixed biofertilizer + 3/4 N + 3/4 P + K (treatment No.15) in both seasons. Results are confirmed with those of Monib *et al.* (1990) on tomato , Sorial *et al.* (1992) and Gomaa (1995) on tomato , Poi (1998) on chili and tomato and Ouda (2000) on tomato. They mentioned the favorable role of Nitrobin (*Azotobacter* or *Azospirillum*) and Phosphorin on both N and P uptake by plant roots.

4.1.4. Effect of biofertilizer treatments on flowering and fruit setting of sweet pepper:

Data (Table, 7) show that plants supplied with NPK without biofertilizer or that supplied with 50% or 75% of the required N and P level + Nitrobin and / or Phosphorin gave similar and higher fruit setting. Therefore, treatments (No.4, 5, 9, 10, 14, 15, and 16) gave similar and higher fruit setting% as compared with all other treatments. This improvement in fruit setting by biofertilizers application have been mentioned by Hewedy (1999) on tomato. Results also means that we can save

25-50% of the required N and P requirements of sweet pepper nutrition by inoculating seeds and transplants roots with a mixture of Nitrobin + Phosphorin. Naturally the microorganisms of free living bacteria in Nitrobin and phosphorus dissolving bacteria (PDB) involved in Phosphorin led to increase the available N and P in the soil and consiquently its uptake by plant roots.

Moreover, data (Table, 7) show that plants supplied with a single or mixed biofertilizer Nitrobin and / or Phosphorin (treatments No.1, 6 and 11) without any chemical fertilizers had the lowest fruit setting % and was similar to that of the control when no bio or chemical fertilizers were added as shown in both seasons. **This result means that adding single or mixed biofertilizer without any chemical fertilizers is not enough to supply plants with macronutrients. This result is in harmony with Barakat and Gabr (1998) on tomato.**

It is also evident from (Table, 7) that treatments (No. 4, 5, 8, 9, 10, 14, 15 and 16) were earlier to the anthesis of 1st flower than the other treatments, as a general trend in both seasons. It means that the inoculation of sweet pepper seeds and transplant roots with Nitrobin and / or Phosphorin + 50 or 75% of the required N-dose + PK led to early anthesis than other treatments. Moreover, inoculating plants with Nitrobin and / or Phosphorin only without adding chemical fertilizers (treatments No.1, 6, 11 and No.17) delayed the anthesis of the first flower to be similar to the control when no bio or chemical fertilizers were addad, as shown in both seasons. As a conclusion, results show that inoculating sweet pepper seeds and transplant roots with single or mixed biofertilizers (Nitrobin and / or Phosphorin) were not able to improve fruit seeting % and delayed the anthesis of the first flower when NPK mineral fertilizers were not added.

However, the most favourable results i.e the highest fruit setting and early anthesis were obtained in plants inoculated with Nitrobin and / or Phosphorin and received 1/2 of the required level of N and P.

As average of both seasons, the earliness in flowering time by treatment (No. 15) reached 8 days and fruit setting percentage was increased from 30.8 up to 65.9 as compared with the control treatment No. 17, without bio or mineral fertilizers. Moreover, a single or mixed biofertilizer treatments did not significantly increase fruit setting or enhance flowering time as compared with solely NPK mineral fertilization (treat. No. 16).

4.1.5. Effect of biofertilizer treatments on early and total fruit yield of sweet pepper and its components:

Data (Table 8 and Figs. 4&5) show that plants received a mixed biofertilizer of Nitrobin and Phosphorin plus 75% of N and P requirements (treatment No.15) gave the highest early and total yield per plant and per feddan as compared with the other treatments followed by treatment No.16 which received the full

dose of NPK in the chemical form without any biofertilizers. These results were true in both seasons. Moreover, data show that plants supplied with a mixed biofertilizer (Nitrobin + Phosphorin) without any chemical fertilizers (treatment No.11) had higher early and total yield than those which received a single biofertilizer i.e either Nitrobin or Phosphorin only; (treatments No.1 and 6, respectively).

Inoculating seeds with Nitrobin and / or Phosphorin singnificantly increased early and total yield over the control when no bio or chemical fertilizers were added, as shown in both seasons. Results on the favourable effect of biofertilizers application on early and total yield have been mentioned by Jackson *et al.* (1964) Mehorta and Lehri , (1971) on eggplant, Antipchuk *et al.* (1982), Mohandas (1987), Bashan and Singh (1989) and Bashan *et al.* (1989) on sweet pepper, Moustafa and Omar (1990) and Gomaa (1995) on tomato.

Generally results show that adding 1/4 , 1/2 or 3/4 of the required level of N and / or P plus inoculation with Nitrobin and/or Phosphorin significantly and gradually increased early yield production per plant and per feddan, as shown in Table 8 and Figs 4&5. Therefore, treatment No.15 gave the highest total yield per feddan and per plant as compared with all other treatments, as shown in both seasons. It means that we can save

25% of the required N and 25% of the required P chemical fertilizer and replace it by inoculating seeds and transplant roots with Nitrobin and Phosphorin. The stimulating effect of living N-fixing bacteria involved in Nitrobin and PDB involved in Phosphorin on increasing plant growth, fruit setting, early anthesis, chlorophyll content, N and P uptake may explain the increase in fruit early and total yield of sweet peppers obtained when plants inoculated with Nitrobin + Phosphorin and received 75% of the required N and P. It means that we cane save 25% of the required level of N and P for sweet pepper nutrition by adding a mixed biofertilizer. This increment in early and total yield production of sweet pepper have been mentioned by Terry *et al.* (1995) and (1996) and Hameedunnisa and Begum (1998) on tomato who saved 25% of the required level of N and Ouda (2000) on tomato who saved 25% of the required level of NPK and could be referred to the role of free living bacteria involved in Nitrobin on N-fixation in the soil and the role of PDB on increasing the available-P in the soil. Moreover, the mechanism of microorganisms on plant growth and fruit yield depends on producing growth promoting substances (El-Haddad *et al.*, 1986) and enhancing nutrients uptake (Sarig, 1984).

Plants which received the full dose of NPK without biofertilizers (treatment No.16) and those that received Nitrobin + Phosphorin + 1/2 N +1/2 P + K. (treatment No. 14) came in the second rank and produced similar total yield per plant and per feddan, as shown in both seasons.

As a general conclusion, inoculating seeds and roots of transplants with Nitrobin + Phophorin and adding 3/4 N + 3/4 P + K (treatment No.15) could be recommended to increase early yield/fed. by 7.14-10.58% and total fruit yield /fed. by 4.42 – 4.53% as compared with the control which recived 100% NPK without any biofertilizers in both seasons, respectively. Treatment No. 15 also increased fruit early yield per fed. by 1.6 – 6.4 times and the total yield/fed. by 4.1 – 4.5 times as compared with the control without bio and chemical fertilizers application in both seasons, respectively.

4.1.6. Effect of biofertilizer treatments on quality of sweet pepper fruits:

4.1.6.a. Fruit physical characteristics :

Data (Table, 9) show that treatments (No. 14, 15 and 16) gave longer, thicker and heavier fruits as compared with all other treatments in both seasons. With respect to fruit diameter, data show that treatments No.15 and 16 gave similar and higher fruit diameter, however treatment No. 15 gave the largest fruit size as compared with all other treatments, in both seasons. This means that 25% of the required N and P fertilizers could be saved by inoculating seeds and transplant roots with Nitrobin + Phosphorin. Saving 50% of the required chemical N and P fertilizers came in the second rank respecting with physical

characteristics of fruit length, diameter and size as a general trend especially in the second season.

Data also show that plants supplied only with a mixed biofertilizer (Nitrobin + Phosphorin , treatment No.11) had better fruit length, diameter and size as well as average fruit weight than in those received a single biofertilizer especially Phosphorin; treatment No.6, as shown in both seasons. It means that the role of Nitrobin on physical characteristics of sweet pepper fruit was more pronounced than Phosphorin, however the interaction between Nitrobin and Phosphorin on fruit quality was clear and increased with adding N and P chemical fertilizers.

Treatment inoculated with Nitrobin + Phosphorin +3/4 N +3/4 P + K (treatment No.15) gave the highest fruit size as compared with other treatments next treatment No.14 which received Nitrobin + Phosphorin + 1/2 N +1/2 P + K and treatment No.16 which received the full dose of NPK without biofertilizers in both seasons. Moreover, treatment No.14, 15 and 16 gave the highest average weight of fruit as compared with other treatments. Also, all biofertilizer treatments significantly increased fruit length, diameter, size and average fruit weight over the control when no bio or chemical fertilizers were added. This trend was true in both seasons.

4.1.6.b. Fruit chemical characteristics :

Data on chemical constituents of sweet pepper fruits are given in (Tables, 10&11). Such data show that inoculating seeds and roots of sweet pepper with Nitrobin and / or Phosphorin did not improve fruit acidity, T.S.S, vitamin C and sugars content unless NPK were added in the chemical form. Therefore, treatments No.1, 6 and 11 gave low and similar fruit quality as a general trend in both seasons.

Concerning the best fruit quality; fruit acidity, T.S.S, vitamin C, plants which received NPK fertilizer without any biofertilizers (treatment No.16) or those which received Nitrobin + Phosphorin + 1/2 N + 1/2 P +K or Nitrobin + Phosphorin + 3/4 N + 3/4 P + K (treatments No.14 or 15) gave similar fruit quality with higher acidity, T.S.S and vitamin-C, as shown in both seasons.

With respect to sugars content of sweet pepper fruit; plants which received all NPK fertilizers in the chemical form (treatment No.16) or that received 75% of the required N and P fertilizers in addition to inoculation with a mixed biofertilizer (treatment No.15) expressed the highest non reducing and total sugars content, in both seasons. This result confirm the role of biofertilizers Nitrobin and Phosphorin on saving 25% of the required level of each element and getting the best fruit quality. Moreover, data show that a mixed biofertilizer (treatment No.11)

and a single biofertilizer (treatments No.1 and 6) significantly increased total sugars over the control when no bio or chemical fertilizers were added. These results are in harmony with Tantawy (2000) who found that all biofertilizer treatments (nitrogen fixing bacteria alone or phosphat dissolving bacteria alone or together) caused a significant increase in T.S.S of tomato fruits .

As a general conclusion plants which received 75% of the required N and P and inoculated with Nitrobin + Phosphorin (treatment No.15) could be considered the best treatment which gave the highest early and total yield with the highest fruit quality in both seasons. Plants that received all NPK in the chemical form without biofertilizers (treatment No.16) or received 50% of the required dose of N and P and inoculated with Nitrobin + Phosphorin (treatment No.14) came in the second rank with respect to early and total yield production.

The stimulating effect of biofertilizers application on fruit early and total yield as well as fruit quality could be referred to the role of N-fixing bacteria involved in Nitrobin and PDB involved in Phosphorin on increasing the available N and P in soil which improved plant growth, NPK uptake, chlorophyll content and consequently increased early and total yield production and improved fruit quality.

4.2. Second Experiment :

Effect of organic fertilizer application on vegetative growth, chemical constituents, flowering, yield and fruit quality of sweet peppers.

4.2.1. Effect of organic-N fertilizer on vegetative growth :

The effect of organic-N fertilizer source on vegetative growth at flowering stage 70 days after transplanting, data (Table, 12) show that plants fertilized with Biogas gave the best vegetative growth characteristics; plant height, No. of leaves, leaf area, fresh and dry weight per plant as compared with other used organic N-sources in both seasons. Whereas, Chicken manure comes in the second rank and equal with Agrolig and FYM in fresh weight but not in dry weight. Also the Agrolig comes in the third rank and equal with FYM in plant height and fresh weight. Whereas, FYM or Agrolig application gave the lowest dry weight per plant, in both seasons.

The superiority of Biogas organic fertilizer on plant vegetative growth may be due to the fact that Biogas is a well ferminted organic fertilizer, free of pathogen sources and seed weeds, added to that the general benefits of organic-N fertilizers, thus it is a good source for most macro and micronutrients and it increases soil porosity and improve aeration of such clay loam soil of this experiment. El-Shimi (1998) and Mikhaeel,*et al.* (1997) on Biogas and FYM , Abo-El-Defan (1990), Eissa (1996) and Abd-El-Aty (1997) on Chicken manure, Corrales *et al.*, (1991) on Chicken and Compost, Lulakis and Petsas (1995) on humic substances, Gianquinto and Borin (1990), Shehata (1992) and Midan (1995) on FYM stated the superiority of Biogas organic fertilizer on plant growth as compared with FYM and Chicken manure.

Concerning the effect of organic-N fertilizer level on vegetative growth 70 days after transplanting, data (Table, 12) show that using 60 kg organic-N only without PK gave the lowest vegetative growth in both seasons.

This result means that organic-N fertilizers had not enough P and K to cover sweet pepper requirements all over the season. Therefore, plants supplied with 60 kg organic-N plus P and K, as super phosphate and potassium sulphate, encouraged vegetative growth. Moreover, it was clear that the most favourable growth of sweet pepper plants was obtained by using 60 kg mineral-N + PK or 30 kg organic-N + 30 kg mineral-N + PK as general trend in both seasons.

Data (Table, 12) also show that the lowest vegetative growth was obtained when plants were fertilized only with 60 kg organic-N/fed. with or without adding any chemical fertilizers i.e P and K. This result indicates that organic-N application only is not quite enough to provide plants with its requirements of macro and micro elements. It is well known that plants absorb N in the mineral form (NO_3^- or NH_4^+). However, organic-N needs several weeks to be converted from the organic-N to the mineral-N, (Tisdale and Nelson, 1975). This may explain the superiority of adding all N fertilizer requirements in the mineral form (60 kg N as ammonium sulphate) or 50% as mineral-N + 50% as organic-N (30 kg N as ammonium sulphate + 30 kg N in the organic source). i.e mineral-N is easly absorbed by plants and organic-N needs a couple of weeks to be converted to mineral-N. Results agree with Abd-El-Aty (1997) who found that addition of organic manure combined with mineral fertilizers is reflected in a slight superiority on plant growth.

Concerning the interaction effect between source and level of N-fertilizer on vegetative growth, 70 days after transplanting, data (Table, 13) show that using 30 kg organic-N as Biogas + 30 kg mineral-N + PK gave the best result in most plant growth characteristics as compared with all used treatments in both seasons. Whereas, using 30 kg organic-N (Chicken manure) + 30 kg mineral-N + PK comes in the second rank and was similar to the control (100% NPK) in most characteristics of plant vegetative growth. However, plants supplied with 60 kg N as FYM only gave the lowest plant growth as compared to all other treatments.

The superior growth of plants fertilized with 50% of N-requirements as Biogas + 50% as mineral-N + PK could be referred to the superiority of Biogas organic fertilizer on plant vegetative growth, thus Biogas is a well fermintated organic fertilizer ; free of pathogen sources and seed weeds, beside the general benefits of organic-N fertilizers thus it is a good source for most macro and micronutrients and increase soil porosity and improve aeration of such clay loam soil of this experiment. Results agree with El-Shimi (1998) and Mikhaeel, *et al.* (1997) who stated the superiority of Biogas organic fertilizer on plant growth.

Referring with the effect of organic-N fertilizer source on vegetative growth 100 days after transplanting, data (Table, 14) show that plants fertilized with Biogas gave the best vegetative growth characteristics; plant height, stem diameter, leaf area, fresh and dry weight per plant as compared with other used organic N-sources in both seasons. The Chicken manure came in the second rank followed by Agrolig , however FYM application led to the lowest fresh and dry weight per plant as compared with the other organic sources. Results on the effect of organic N-fertilizers on plant growth are in harmony with El-Shimi (1998) and Mikhaeel, *et al.* (1997) on Biogas and FYM , Abo-El-Defan (1990), Eissa (1996) and Abd-El-Aty (1997) on Chicken manure, Corrales *et al.*, (1991) on Chicken manure, Gianquinto and Borin

(1990), Shehata (1992) and Midan (1995) on FYM who stated the superiority of Biogas organic fertilizer on plant growth.

With concern to the effect of organic-N fertilizer level on vegetative growth 100 days after transplanting, data (Table, 14) show that using 60 kg organic-N without PK gave the lowest vegetative growth in both seasons. This result means that organic-N fertilizers alone had insufficient amount of P and K needed to cover sweet pepper requirements allover the season. Therefore, the application of 60 kg organic-N plus P as super phosphate and K as potassium sulphate encouraged vegetative growth. Moreover, it is clear that the most favourable growth of sweet pepper plants was obtained by using 30 kg organic-N + 30 kg mineral-N + PK followed by using 60 kg mineral-N + PK as general trend in both seasons. In this connection, Abd-El-Aty (1997) found that the addition of organic manure combined with chemical fertilizers reflected a slight superiority on plant growth.

The superiority of using 50% of the required N in the organic form and 50% in the mineral form on vegetative growth may be due to the favorable effect of the mineral nitrogen on the activity of micro organisms responsible for organic fertilizer analysis in the soil (Follett *et al.* , 1981).

With respect to the interaction between source and level of N-fertilizer on vegetative growth 100 days after transplanting, data (Table, 15) show that using 30 kg organic-N as Biogas + 30 kg mineral-N + PK gave the highest plant growth; plant height, stem diamter, leaf area, fresh and dry weight as compared with all used treatments in both seasons. Meanwhile, using 30 kg organic-N as Chicken manure + 30 kg as mineral-N + PK came in the second rank. Also using 30 kg organic-N as Agrolig + 30 kg as mineral-N + PK comes in the third rank and plants supplied with 30 kg N as FYM + 30 kg mineral-N had the lowest plant growth, as shown in both seasons. These obtained results agree with Mikhaeel *et al.* (1997) and El-Shimi (1998), who stated the superiority of Biogas organic fertilizer on plant growth.

4.2.2. Effect of organic-N fertilizer on NPK uptake and chlorophyll content in leaves (70 days after transplanting):

Concerning the effect of organic-N fertilizer source on NPK uptake 70 days after transplanting, data of plant analysis (Table, 16) show that plants supplied with organic-N as Biogas removed higher quantities of N, P and K than that of plants supplied with other organic-N sources. Plants fertilized with Chicken manure accumulated similar quantities of phosphorus to that of Biogas, but comes in the second rank with respect to N and K uptake and accumulation in leaves, stem and total foliage. However, Plants supplied with FYM had the lowest N and K uptake (mg/plant) as compared with the other sources.

Generally, according to N and K uptake, Biogas led to the highest uptake followed by Chicken manure and followed by Agrolig, however, FYM gave the lowest N and K uptake, as a general trend in both seasons. This result may be referred to the high potassium content of Biogas and Chicken manure than that of Agrolig or FYM. Added to that the Biogas organic fertilizer is well fermentated during Biogas production cycle in the fermentators. Abo-El-Defan (1990) on Chicken manure, Abd-El-Aty (1997) on pigon and Chicken manure, El-Shimi (1998) on Biogas and Siminis *et al.*(1998) on humic substances found that these fertilizers were the best organic sources.

With respect to the effect of organic-N fertilizer level, data (Table, 16) show that adding all nitrogen fertilizer requirements in the organic form (60 kg N/fed.) with or without adding P and K led to a lower nitrogen, phosphorus and potassium uptake as compared with that when all nitrogen fertilizer requirements were added as 50% or 100% as mineral nitrogen i.e as ammonium sulphate. Data also show that adding 30 kg N in the organic form + 30 kg N in the mineral form gave higher and similar N and P uptake to that treatment which received all N in the mineral form, as a general trend in both seasons. However, adding 50% of N as organic and 50% as mineral (30 kg organic-N + 30 kg chemical-N + PK) gave the highest K uptake, as shown in both seasons. These results may be referred to the high potassium content of organic fertilizer added to its effect on mineralization and availability of soil N,P and K.(Tisdale and Nelson, 1975)

With respect to the interaction between source and level of N-fertilizer, data (Tables, 17 and 18) show that plants supplied with 30 kg N as Biogas or Chicken manure + 30 kg N in the

mineral form as ammonium sulphate (treatments No.3 and 11) had higher N, P and K uptake than those that received the same dose of organic fertilizer as FYM or Agrolig (treatments No.7 and 15), as shown in both seasons. However, plants supplied with 60 kg N as FYM only gave lower NPK uptake than all other treatments. Abd-El-Aty (1997) reached to simillar results and found that addition of organic manure (pigeon or chicken manures) combined with chemical fertilizers increased N, P, and K content of leaves.

Concerning the effect of organic-N fertilizer source on chlorophyll content of leaves, data (Table, 16) show that organic sources (Biogas, Chicken manure, Agrolig and FYM) significantly differed from each other in a descending order, with respect to chlorophyll-A in leaves. With respect to chlorophyll-B content of leaves, it did not differ significantly due to organic-N fertilizer source, in both seasons. Plants fertilized with Biogas and Chicken manure had higher total chlorophyll content in leaves than that of the other sources. However, no significant differences between Agrolig and FYM were detected with respect to total chlorophyll content, in both seasons.

Concerning the effect of organic-N fertilizer level on chlorophyll content, data (Table, 16) show that using 60 kg organic-N without PK led to the lowest content of chlorophyll-A and/or B in leaves, in both seasons. The highest chlorophyll-A and total chlorophyll content in leaves were obtained by using 60 kg mineral-N + PK followed by using 30 kg organic-N + 30 kg mineral-N + PK, especially in the first season with no significant difference in chlorophyll-B content in both seasons. However, adding 30 kg organic-N + 30 kg mineral-N + PK or adding 60 kg mineral-N + PK gave similar total chlorophyll content in leaves, in the second season.

According to the interaction effect between source and level of organic-N fertilizer on chlorophyll content, data (Tables, 17&18) show that using 30 kg organic-N as Biogas + 30 kg mineral-N + PK (treatment No.3) gave high chlorophyll-A content as compared with all other treatments followed by using 30 kg organic-N as Chicken manure + 30 kg mineral-N + PK (treatment No.11) with no significant differences than using 60 kg mineral-N + PK (control) treatment No.12, in both seasons.

Data also show that adding 50% of nitrogen within all used organic sources (Biogas, FYM, Chicken manure or Agrolig) + 50% mineral-N + PK (treatments 3, 7, 11, 15) gave equally higher chlorophyll-B content with that received 100% of N as mineral form, as shown, in both seasons. It seems that organic-N application had a pronounced effect on chlorophyll-B content of leaves. Generally, adding 30 kg organic-N as (Biogas or Chicken manure) + 30 kg mineral-N + PK gave higher total chlorophyll content as compared with all other treatments and equal with that of the control in both seasons. Results agree with Abd-El-Aty (1997) who found that addition of organic manure (pigeon or chicken manures) combined with chemical fertilizers increased chlorophyll content of leaves.

4.2.3. Effect of organic-N fertilizer on NPK uptake (100 days after transplanting):

The effect of organic-N fertilizer source, data (Table, 19) on N, P and K uptake in different plant organs; leaf, stem and fruits allover the season show that plants fertilized with Biogas manure had significantly higher nitrogen and potassium uptake than the other used sources, as shown in both seasons. However, plants supplied with Biogas, Chicken and Agrolig manure gave similar results of P-uptake as a total accumulation in leaves, stem and fruits, as shown in both seasons. On the other hand, plants supplied with FYM show the lowest N and K content as total uptake (mg/plant). Abo-El-Defan (1990) on Chicken manure, Abd-El-Aty (1997) on pigon and Chicken manure, El-Shimi (1998) on Biogas and Siminis *et al.*(1998) on humic substances, reported that these sources were the best organic fertilizers.

Cocerning with the effect of organic-N fertilizer level on NPK uptake, data (Table, 19) show clearly that adding all nitrogen requirements in the organic form (60 kg organic-N/fed.) decreased NPK uptake. However, adding all N fertilizer in the mineral form (60 kg N as ammonium sulphate) gave higher N and P uptake and similar to that received 30 kg organic-N + 30 kg mineral-N. However, potassium uptake showed the highest values when plants received 50% of N each as organic or mineral form. These results show the same trend previously discussed 70 days after transplanting (4.2.2) .

Respecting with the effect of interaction treatments on NPK uptake, data (Tables, 20 and 21) and Figs (6, 7 and 8) show that adding 50% of nitrogen fertilizer in the organic form especially as Biogas or Chicken manure and the other 50% of nitrogen in the mineral form (30 kg organic-N + 30 kg mineral-N , treatments No.3 and 11) gave higher N, P and K uptake as compared with all other treatments in both seasons. This result could be referred to the high PK analysis of Biogas and Chicken manure (Table, C), added to that Biogas manure is a well fermentated organic source, easy to be mineralized in the soil (El-Shimi 1998). On the other hand, plants supplied with 50% of nitrogen as FYM or Agrolig (treatments No. 7 and 15) and the other 50% as mineral N, did not increase N and P uptake as compared with those received all N-requirements in the mineral form.

As a general conclusion, adding 50% of N requirements of sweet pepper fertilization as Biogas or Chicken manure and the other 50% as mineral-N as ammonium sulphate (treatments No. 3 and 11) could be recommended to increase NPK uptake than adding all nitrogen fertilizer requirements in the organic or mineral form. Results completely agree with Abd-El-Aty (1997) who found that addition of organic manure (pigeon or chicken

manures) combined with chemical fertilizers increased N, P, and K content of leaves.

<u>4.2.4. Effect of organic-N fertilizer on flowering and fruit setting of sweet pepper :</u>

Concerning the effect of organic-N source, data (Table, 22) show that adding Biogas manure increased fruit setting and decreased days to the anthesis of the 1st flower as compared with FYM, in both seasons. However, using FYM, Chicken and Agrolig gave similar fruit setting and anthesis time with no significant differences between them, in both seasons.

Respecting with level of organic-N fertilizer, data (Table, 22) show that using 60 kg organic-N only gave the lowest fruit setting and delayed the anthesis of the 1st flower, as compared with the lower N-levels, in both seasons. It is also noticed that using 60 kg mineral-N +PK or 30 kg organic-N +30 kg mineral-N + PK resulted an increase or improvement in fruit setting and accelerated flowering time in both seasons.

Concerning the effect of interaction treatments, data (Table, 23) show that using 30 kg organic-N within any source

(Biogas, Chicken manure, Agrolig or FYM) + 30 kg mineral-N + PK gave the highest fruit setting with earlier anthesis and equal to that of the control (which received 60 kg mineral-N + PK), in both seasons. The best treatment that increased fruit setting and accelerated anthesis was adding 30 kg organic-N in the form of

biogas + 30 kg mineral-N + PK or adding 60 kg as mineral-N +PK, meanwhile the worst treatment was adding 60 kg organic-N in the form of FYM only.

4.2.5. Effect of organic-N fertilizer on early and total yield of sweet pepper and its components :

According to early and total yield (ton/fed.) as affected by organic-N source, data (Table, 24 and Figs, 9&10) show that Biogas and Chicken manure were similar and better sources which gave higher early and total yield than that of FYM and Agrolig ,as shown in both seasons. With respect to early and total yield (g/plant), Biogas, Chicken, Agrolig and Farmyard manure significantly differed from each other in a descending order.

Such variation between different organic sources with respect to early and total yield may be due to the variation of humus substances production which improves the physical and chemical properties of soil as well as increasing nutrients released and hence their availability to plant uptake. Data (Tables 16, 17, 18, 19, 20 and 21) on NPK uptake and accumulation in leaves, stem and fruits indicate that Biogas and Chicken manure resulted higher NPK nutrients than that of other organic N-sources. These results are in agreement with those obtained by Singh (1989) on Biogas manure, Ranganna *et al.*

(1991) on Biogas and FYM and Eissa (1996) on Chicken and FYM and El-Shimi (1998) on Biogas and FYM.

with respect to the effect of organic-N fertilizer level on early and total yield, data (Table, 24) show that adding all N-fertilizer in the mineral form as ammonium sulphate or adding 30 kg N in the organic form + 30 kg N in the mineral form gave similar early and total yield and were higher than adding all N requirements only in the organic form (60 kg organic-N/fed.) either with or without P and K application. The same trend was detected also in the second season. These results may be referred to the shortage of phosphorus and potassium content of the organic fertilizers. therefore, the treatments which supplied with 60 kg mineral nitrogen without any organic fertilizers plus PK gave higher early and total yield as compared with those received all nitrogen dose (60 kg N/fed.) in the organic form (Biogas, FYM, Chicken manure or Agrolig) without adding P and K. It means that the organic fertilizers may cover 50% of the required N nutrition of sweet pepper but it failed to cover P and K requirements. The superiority of adding 50% of N in the organic form (30 kg N in the organic form + 30 kg N in the mineral form + PK) over adding all N-fertilizer in the organic form (60 kg organic-N + PK) may be referred to the easier and quicker analysis of organic-N when soil received half of N in the mineral form which increased the available-N in the soil, and increased microorganisms activity in the same time (Follett *et al.*, 1981).

Results are confirmed with those of Abd-El-Aty (1997), who found that adding organic-N and mineral N-fertilizers together increased crop yield of sweet pepper than adding each N-source alone. In this connection, Patil *et al.* (1998) found that adding vermicompost save 50% of the required mineral-N applied to tomato.

Concerning the interaction between source and level of organic-N fertilizer, it is evident from Table (25) and Figs. (9 & 10) that the treatments which received 30 kg N in the organic form (Biogas and Chicken manure) + 30 kg N in the mineral form + PK, gave the highest early yield in both seasons, followed by Agrolig which came in the second rank and equal with the control (60 kg as mineral-N + PK). It is also evident that the treatments received 30 kg N in the organic form (Biogas manure) + 30 kg N in the mineral form + PK, gave the highest total yield, in both seasons. Whereas, plants received 30 kg N in the organic form (Chicken manure) + 30 kg N in the mineral form + PK, came in the second rank and equal with the control

(60 kg as mineral-N + PK). However, plants supplied with 60 kg N as FYM only gave the lowest early and total yield than all other treatments. These results are in agreement with those obtained by Gianquinto and Borin (1990) on tomato and Abd-El-Aty (1997) on sweet pepper.

4.2.6. Effect of organic fertilizer treatments on quality of sweet pepper fruits

4.2.6.a. Fruit physical characteristics:

Concerning the effect of organic-N fertilizer source on fruit quality, data (Table, 26) show that using Biogas as a source of organic-N gave the best quality of sweet pepper fruits i.e. length, diameter, size and weight as compared with the other used organic-N sources in both seasons. Concerning fruit length and diameter, Chicken manure produced similar results such Biogas only in the first season, but fruit size and average fruit weight of plants fertilized with Biogas manure is still the favourate one within all organic-N sources in both seasons. With respect to fruit size and average fruit weight, Agrolig fertilizer gave the smallest values as compared with the other organic-N sources, in both seasons. The superiority of Biogas organic fertilizer on fruit quality may be due to the fact that Biogas is a well fermentated organic fertilizer and free of pathogen sources and seed weeds and it is a good source for most macro and micro nutrients, (El-Shimi, 1998).

According to the effect of organic-N fertilizer level on fruit quality, data (Table, 26) show that adding 30 kg organic-N + 30 kg mineral-N + PK gave larger fruit size and similar fruit weight as compared with that of plants received all required-N in the mineral form; 60 kg mineral-N + PK, in both seasons. Data also show that adding all N-requirements of sweet pepper (60 kg N/fed.) in the organic form depressed all physical characteristics of fruit quality thus the smallest fruit size and weight was obtained when plants were supplied with 60 kg organic-N only i.e without adding P and K fertilizers.

These results elucidate that organic-N application alone is not enough to supply sweet pepper plants with NPK required for plant growth, yield and adequate to improve fruit quality. On the other hand, adding 50% of the required-N in the organic form and 50% in the mineral form improved fruit physical characteristics similar to that of using 100% of N application in the mineral form. The superiority of adding 30 kg organic-N + 30 kg mineral-N may be due to that mineral-N is easily and quickly taken up by plant roots than organic-N and the latter needs a time to be converted to NH^{+}_{4} and consequently to NO^{-}_{3} available for plant uptake. It means that the presence of mineral-N is quite preferable for the mineralization of organic-N which is essential first to increase the available soil-N. This explanation agree with those of Tisdale & Nelson, (1975).

Concerning the interaction between source and level of organic-N fertilizer on fruit quality (physical characteristics), data (Table, 27) show that using 30 kg N as Biogas + 30 kg mineral-N + PK gave the largest fruits with the heaviest weight as compared with all other treatments, in both seasons. The superiority of this treatment may be due to the interaction between organic-N and mineral-N on mineralization and availability of nitrogen in the soil as previously discussed. Data also show that using 30 kg mineral-N + 30 kg N as Chicken manure comes in the second rank with respect to its effect on fruit physical quality, as shown in both seasons.

Generally, results show that adding 30 kg mineral-N + 30 kg N as Chicken manure plus PK (treatments No.11) gave better fruit quality than adding all N requirements in the mineral form (treatments No.12). Abd-El-Aty (1997) found that addition of organic manure (pigeon or chicken manures) combined with chemical fertilizers gave the best fruit quality.

On the other hand, using 50% of the required nitrogen as FYM or Agrolig (treatments 7 and 15) decreased or gave similar fruit quality as those of plants which received 100% of the required N in the mineral form i.e as ammonium sulphate.

4.2.6.b. Fruit chemical characteristics :

Respecting with the effect of organic-N fertilizer source on fruit chemical quality, data (Table, 28) show that there were no significant differences in fruit acidity due to organic-N source, in both seasons except for FYM which slightly decreased fruit acidity as compared with that of Biogas, in the second season. Data also show that adding Biogas and Chicken manure gave similar and higher T.S.S of sweet pepper fruits than that of FYM as a general trend in both seasons. However, T.S.S of fruits fertilized with FYM or Agrolig were not significantly differed from each other, in both seasons.

Vitamin-C content of sweet pepper fruits, did not differ significantly due to organic-N fertilizer source, in both seasons. It seems that vitamin-C is mainly affected by variety, ripening stage (Somos, 1984) and less affected by organic-N source.

According to sugar content of sweet pepper fruits, data show that plants fertilized with Biogas manure had the highest total sugar content, followed by Chicken manure, Agrolig and FYM in a descending order with a significant differences between organic-N sources. This result was true in both seasons and could be referred to the enhancing effect of Biogas manure application on reducing and non-reducing sugar of sweet pepper fruit as compared with that plants supplied with other N-sources especially FYM. This result is in harmony with Abd-El-Aty (1997) who found that pigeon and chicken manures were the best organic N-sources compared with cattle and town refuse.

The effect of organic-N fertilizer level on fruit quality; data (Table, 28) show that adding 60 kg mineral-N + PK or 30 kg organic-N + 30 kg mineral-N + PK led to the highest content of acidity, T.S.S, vitamin-C and total sugars content of sweet pepper fruits. Also using 60 kg organic-N + PK comes in the second rank, but using 60 kg organic-N only gave the lowest values, in both seasons.

Generally, data of sugars content show that increasing the quantity of organic-N application (from 30 up to 60 kg N) decreased non-reducing and total sugars content of sweet pepper fruits but increased its reducing sugars, i.e. that plants supplied with 60 kg organic-N + PK had lower non-reducing and total sugars than that of plant supplied with 30 kg organic-N + 30 kg mineral-N. Therefore, the highest non-reducing and total sugars content was obtained in fruits of plants fertilized with 60 kg mineral-N. This stimulating effect of mineral-N on fruit sugars content may be referred to the effect of mineral-N nutrition on chlorophyll content of leaves (Tables, 17&18) and consequently on sugars formation through photosynthesis.

Concerning the effect of interaction between source and level of organic-N fertilizer on fruit quality, data (Tables, 29&30) show that using 30 kg N within any organic form + 30 kg mineral-N + PK increased fruit acidity, T.S.S and vitamin-C content as compared with other treatments except when was added as 60 kg mineral-N + PK (control) , as shown in both seasons. Whereas, using 30 kg organic-N as Biogas + 30 kg mineral-N + PK gave highest fruit content of reducing and total sugars than using 60 kg mineral-N + PK (control), in both seasons. However, using 30 kg organic-N (Chicken manure) + 30 kg mineral-N + PK gave similar total sugars content to that of plants which received all N requirements in the mineral form (60 kg mineral-N + PK). Also, using 30 kg organic-N as Agrolig or FYM + 30 kg mineral-N + PK gave lower total sugars content

than the control where all N-fertilizer was added in the mineral form, as shown in both seasons.

Generally, using 30 kg organic-N as Biogas + 30 kg mineral-N + PK gave the highest total sugars content of fruits followed by using 30 kg organic-N as Chicken manure + 30 kg mineral-N + PK, as shown in both seasons. Abd-El-Aty (1997) found that addition of organic manure (pigeon or chicken manures) combined with chemical fertilizers gave the highest fruit content of vitamin-C , acidity and TSS.

Concerning heavy metals content of sweet pepper fruits, data (Table, 28) show that organic-N sources were relative higher in heavy metals than the mineral N-source. The addition of Chicken manure led to the highest relative values of Pb, Ni and Cd in sweet pepper fruits. However, FYM gave the lowest content of these heavy metals in fruits.

Data (Tables, 29&30) show that adding organic manures within any used source FYM, Agrolig, Biogas or Chicken manure in ascending order, increased the concentrations of heavy metals, i.e. Pb, Ni and Cd in pepper fruit although these concentrations are still less than the critical limit permitted to be found in normal plants (Eissa, 1996).

Whereas, addition of 60 kg organic-N as Chicken manure + PK gave the highest relative values of Pb, Ni and Cd concentration but still less than the critical limits permitted to be found in normal plants, in both seasons, (Eissa, 1996).

5. SUMMARY & CONCLUSION

Two separate field experiments on sweet pepper (Capsicum annuum L.) cv. California Wonder were carried out at the Experimental Farm of the Faculty of Agriculture, Moshtohor, during the summer seasons of 2000 and 2001. The farm had a clay loam soil with pH 7.5. Sowing of Sweet pepper seeds took place in the nursery at 15 th January and transplanting took place in 24 th March in both seasons of this study.

5.1. First Experiment :

Effect of biofertilizer application on vegetative growth, chemical constituents, flowering, yield and fruit quality of sweet peppers.

The aim of this experiment is to investigate the effect of inoculating seeds and transplants roots of sweet pepper cv. California Wonder with a single or mixed biofertilizer; Nitrobin and/or Phosphorin. This experiment included 17 treatments as follows :

Treatments from No. 1 to 5 received Nitrobin as a single biofertilizer alone or with 0 , 25 , 50 or 75% of the recommended N-dose (80 kg / fed.), however P and K were added at the standard level of 64 kg P_2O_5 + 96 kg K_2O /fed. Treatments from No. 6 to 10 received Phosphorin alone or with 0 , 25 , 50 or 75% of the required P-level. (64 kg P_2O_5/fed.), however N and K were added at the standard level of 80 kg N + 96 kg K_2O /fed. Referring with mixed biofertilizer treatments; it received Nitrobin + Phosphorin alone (treatment No.11) or with 0 , 25 , 50 or 75% each of the required N and P_2O_5 dose (treatments No. 12-15) added to standard level of potassium (96 kg K_2O /fed.). The two control treatments i.e. treatment (No. 16) received only 100% NPK as mineral fertilizers (80 kg N + 64 kg P_2O_5 + 96 kg K_2O/fed.) and treatment (No. 17) did not receive any bio or chemical fertilizers application (without both bio and chemical fertilizers).

The 17 treatments were arranged in a randomized complete block design with four replicates. Obtained results revealed the following :-

1. Vegetative growth characteristics :-

Plants received mixed biofertilizer of Nitrobin + Phosphorin + 3/4 N + 3/4 P + K (treat. No.15) showed the most favorable effect on plant growth parameters i.e. plant height , stem diameter , number of leaves , leaf area and dry weight per plant followed by those received the full dose of NPK without biofertilizers (treat. No.16) or those received Nitrobin + Phosphorin + 1/2 N + 1/2 P + K (treat. No.14). This trend held true at either 70 or 100 days after transplanting and during both seasons of the experiment.

2. Chemical composition of leaves and plant foliage :

A. NPK uptake :

Inoculating plants with Nitrobin and/or Phosphorin significantly increased NPK uptake in the two growth stages and this increase was significant and gradual with increasing levels of N and/or P application from 25%, 50% upto 75% of each element. Therefore, the maximum NPK uptake/plant was obtained from (treatment No.15) when transplants was inoculated with Nitrobin + Phosphorin and fertilized with 3/4 N + 3/4 P + K in both seasons at the two stages i.e. (70 and 100 days after transplanting). On the other hand, plants supplied with NPK in the mineral form without any biofertilizers (treatment No.16) accumulated less NK at 70 days after transplanting or less NPK at 100 days after transplanting as compared with plants supplied with a mixed biofertilizer + 3/4 N + 3/4 P + K . This trend was true in both seasons and results could be referred to the role of Nitrobin and Phosphorin on increasing NPK uptake.

B. Chlorophyll content of leaves :

Plants inoculated with Nitrobin + Phosphorin + 50% or 75% of both NP + K and those received 100% NPK without biofertilizers gave similar and higher chlorophyll A,B and total as compared with all other treatments, as shown in both seasons. Moreover, a mixed biofertilizer (treatment No.11) and a single biofertilizer (treatment No.1 and 6) significantly increased chlorophyll A and total chlorophyll over the control when no bio or chemical fertilizers were added, with no significant differences in chlorophyll B as shown in both seasons.

3. Flowering and fruit setting :

Plants inoculated with Nitrobin + Phosphorin + 75% of both NP + full K (treatment No. 15) flowered 8 days earlier and fruit setting percentage was increased from 30.8 up to 65.9 as compared with the control treatment No. 17 (without bio or mineral fertilizers). Moreover, treatment (No. 15) did not significantly increased fruit setting or enhanced flowering time as compared with solely NPK mineral fertilization (treat. No. 16).

4. <u>Early and total fruit yield :</u>

Inoculating seeds and roots of transplants with Nitrobin and/or Phosphorin increased early and total yield per plant and per feddan as compared with the control when no bio and chemical fertilizers were added in both seasons. Moreover, inoculation with Nitrobin and/or Phosphorin added to 0, 25, 50% of NP required dose gradually increased early and total yield. Whereas, no significant increase in total yield was obtained when plants inoculated with single biofertilizer; Nitrobin or Phosphorin + (50 or 75%) of NP required dose as chemical fertilizers.

As a general conclusion inoculating seeds and roots of transplants with mixed biofertilizers; Nitrobin + Phosphorin and adding 75% of the erquired NP + K (treatment No.15) could be recommended thus it increased early yield/fed. by 7.14-10.58% and total fruit yield/fed. by 4.42-4.53% as compared with the control which received 100% NPK without any biofertilizers, in both seasons. Treatment No.15 also increased fruit early yield per fed. by 1.6-6.4 times and the total yield/fed. by 4.5-4.9 times as compared with the control (No. 17) without bio and chemical fertilizers application, in both seasons.

5. <u>Quality of sweet pepper fruits :</u>

Treatments inoculated with mixed biofertilizer; Nitrobin + Phosphorin +3/4 N +3/4 P + K (treatment No.15) or that fertilized with 100% NPK in the mineral form without biofertilizers (No. 16) gave the highest fruit length, diameter, average fruit weight as compared with other treatments, in both seasons.

Concerning with the best fruit quality; fruit acidity, T.S.S, vitamin C, plants received NPK fertilizer without any biofertilizers (treatment No.16) or those received Nitrobin + Phosphorin + 1/2 N + 1/2 P +K or Nitrobin + Phosphorin + 3/4 N + 3/4 P + K (treatments No.14 or 15) gave similar fruit quality with high constituents, as shown in both seasons. With respect to sugar content of sweet pepper fruit; plants received all NPK fertilizers in the chemical form (treatment No.16) or received 75% of the required N and P (treatment No.15) expressed the highest non reducing and total sugars content. This result confirm the role of biofertilizers Nitrobin and Phosphorin on saving 25% of the required level of each element and getting the best fruit quality.

Conclusion

As a general conclusion inoculating seeds and roots of transplants with a mixed biofertilizers; Nitrobin + Phosphorin and fertilized with 75% of N and P required level; (60 kg N + 48 kg P_2O_5 + 96 kg K_2O) gave the highest growth, early and total yield per feddan with the best fruit quality of sweet pepper, cv. California Wonder when grown in clay loam soil. You can save

25% of N and P fertilizer level by adding Nitrobin and Phosphorin.

5.2. Second Experiment :

Effect of organic fertilizer application on vegetative growth, chemical constituents, flowering, yield and fruit quality of sweet peppers.

This experiment was carried out to investigate the response of sweet pepper plants cv. California Wonder to 4-organic N-sources within 4-methods of N-application in order to produce high yield of sweet pepper fruits with less contamination.

Therefore, this experiment included 16 treatments, 4-organic fertilizer sources (Biogas, FYM, Chicken manure and Agrolig) within 4-methods of N-application (60 kg N-organic only, 60 kg N-organic + PK, 30 kg N-organic + 30 kg N-mineral + PK and the control treatment supplied with 60 kg N-mineral + PK as 64 kg P_2O_5 and 96 kg K_2O) .

Experimental treatments were arranged in a randomized complete block design with 4 replicates. Obtained results revealed the following:-

1. **Vegetative growth characteristics :-**

Data of organic fertilizer sources indicated that plants fertilized with Biogas gave the best vegetative growth characteristics; plant height, No. of leaves, leaf area, fresh and dry weight per plant followed by Chicken manure, Agrolig and FYM.

Methods of N-application show that the most favourable growth of sweet pepper plants was obtained by using 60 kg mineral-N + PK or 30 kg organic-N + 30 kg mineral-N + PK as general trend.

Data of interaction between sources and methods of N-application show that using 30 kg organic-N as Biogas + 30 kg mineral-N + PK gave the best result in most characteristics of plant growth especially plant dry weight as compared with all used treatments. This trend held true at either 70 or 100 days after transplanting and during both seasons of the experiment.

2. <u>Chemical composition of leaves and plant foliage :</u>

A. <u>NPK uptake :</u>

Adding Biogas led to the highest uptake of N and K followed by Chicken manure, and Agrolig, however, FYM showed the lowest N and K uptake, as a general trend in both seasons and in two stages of plant growth.

Methods of N-application show that adding 30 kg organic-N + 30 kg mineral-N + PK, gave higher and similar N and P uptake to that treatment which received all N in the mineral form, as a general trend in both seasons. However, adding 50% of N as organic and 50% as mineral (30 kg organic-N + 30 kg chemical-N + PK) gave the highest K uptake, as shown in both seasons and in the two stages of plant growth.

Data of interaction between sources and methods of N-application show that adding 50% of N fertilizer requirements in the organic form (30 kg N) especially as Biogas or Chicken manure + 50% as mineral-N (30 kg N) + PK could be recommended to increase N, P and K uptake of sweet pepper plants. than adding all nitrogen fertilizer requirements (60 kg N/fed.) in the organic or mineral form.

B. <u>Chlorophyll content of leaves :</u>

Data show that using 60 kg organic-N without PK led to the lowest content of chlorophyll-A and/or B in leaves, in both seasons. Furthermore, adding 50% of nitrogen within all used organic sources (Biogas, FYM, Chicken manure or Agrolig) + 50% mineral-N + PK gave higher chlorophyll-B content and equal with that of the control of plants received 100% of N as mineral form as shown in both seasons.

3. <u>Flowering and fruit setting :</u>

Using 30 kg organic-N within any source (Biogas, Chicken manure, Agrolig and FYM) + 30 kg mineral-N + PK gave the highest fruit setting with earlier anthesis and equal to that of the control (which received 60 kg mineral-N + PK) in both seasons.

4. <u>Early and total fruit yield :</u>

With respect to early and total yield per plant or feddan, Biogas, Chicken, Agrolig and Farmyard manure were significantly differed from each other in a descending order.

Plants supplied with 100% N only in the mineral form (60 kg N/fed. + PK) or those received 50% N in the organic form +

50% in the mineral form (30 kg organic-N + 30 kg mineral-N + PK) gave high early and total yield (ton/fed.) as compared with the other N-methods in both seasons.

Concerning with the interaction between sources and methods, data show that treatments received 30 kg N in the organic form (Biogas or Chicken manure) + 30 kg N in the mineral form + PK, gave the highest early yield per plant and per feddan, as a general trend in both seasons. Treatments received 30 kg N in the organic form (Biogas manure) + 30 kg N in the mineral form + PK, gave the highest total yield per plant and per feddan in both seasons. Whereas, treatments received 30 kg N in the organic form (Chicken manure) + 30 kg N in the mineral form + PK, came in the second rank with respect to total yield and equal with the control (60 kg as mineral-N + PK). However, plants supplied with 60 kg N as FYM only gave lowest early and total yield as compared with all other treatments.

5. <u>Quality of sweet pepper fruits :</u>

Using 30 kg N as Biogas + 30 kg mineral-N + PK gave larger fruit size, average fruit weight and the best chemical properties (acidity, T.S.S, vitamin-C) as compared with all other treatments, in both seasons. Data also show that using 30 kg mineral-N + 30 kg N as Chicken manure comes in the second rank with respect to its effect on fruit quality (physical & chemical) , as shown in both seasons.

On the other hand, using 50% of the required nitrogen as FYM or Agrolig decreased or gave similar fruit quality as compared with that of plants received 100% of the required N in the mineral form (ammonium sulphate). This result indicate the superiority of adding 50% of nitrogen fertilizer as Biogas or as Chicken manure.

Data on sugars content show that increasing the quantity of organic-N application (form 30 upto 60 kg N) decreased non-reducing and total sugars content of sweet pepper fruits but increased its reducing sugars. In this regared, plants supplied with 60 kg organic-N + PK had lower non-reducing and total sugars than those supplied with 30 kg organic-N + 30 kg mineral-N. Therefore, the highest non-reducing and total sugars content was obtained in fruits of plants fertilized with 60 kg mineral-N.

Generally, using 30 kg organic-N as Biogas + 30 kg mineral-N + PK gave the highest total sugars content of fruits followed by using 30 kg organic-N as Chicken manure + 30 kg mineral-N + PK, as shown in both seasons.

6. Heavy metals content of sweet pepper fruits :

Adding organic manures within any used source (Chicken manure, Biogas, Agrolig and FYM) in a descending order increased the concentrations of heavy metals, i.e. Pb, Ni and Cd in pepper fruit. Whereas, addition of 60 kg organic-N within any source + PK show the highest values of Pb, Ni and Cd ppm concentrations in pepper fruit, in both seasons. However, adding 60 kg N in mineral form gave the lowest values of heavy metals accumulation in fruits.

Whereas, addition of 60 kg organic-N as Chicken manure + PK gave the highest relative values of Pb, Ni and Cd ppm concentrations but is still less than the critical limits permitted to be found in normal plants.

Conclusion

It can be generally concluded that sweet pepper plants supplemented with 30 kg N in the organic form (Biogas manure) + 30 kg N in the mineral form (ammonium sulphate) + 64 kg P_2O_5 + 96 kg K_2O , gave the most favourable growth, the highest early and total yield per feddan with the best fruit quality of sweet pepper plants, cv. California Wonder grown in clay loam soil.

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الملخص العربي

أجريت تجربتان حقليتان على نبات الفلفل الحلو صنف كاليفورنيا وندر بمزرعة الخضر بكلية الزراعة بمشتهر أثناء الموسم الصيفى لعامى 2000 ، 2001 . فى أرض طينية صفراء ذات رقم حموضة 7.5 . تم زراعة البذور بالمشتل فى 15 يناير وتم نقل الشتلات بالأرض المستديمة فى 24 مارس فى كلا موسمى الزراعة.

(أ) <u>التجربة الأولى :</u>

" تأثير التسميد الحيوى على النمو الخضرى والتركيب الكيماوى والازهار والمحصول وجودة ثمار الفلفل."

وفى هذه التجربة تم تلقيح بذور الفلفل أثناء زراعتها بالمشتل وجذور الشتلات قبل زراعتها بالحقل المستديم باستخدام كل من النتروبين أو الفوسفورين أو مخلوط منهما معا. وذلك بغرض دراسة تأثير التلقيح بالأسمدة الحيوية على النمو والمحصول وجودة ثمار الفلفل.

اشتملت هذه التجربة على 17 معاملة كالتالى:

المعاملات من رقم 1 إلى 5 أخذت تسميد حيوى منفرد بالنتروبين فقط أو مع (صفر ، 25 ، 50 ، 75%) من مستوى النيتروجين الموصى به (80 كجم ن / فدان) وذلك بالإضافة الى الفوسفور والبوتاسيوم حيث تم إضافتهم بالمستوى القياسى الموصى به وهو 64 كجم فو$_2$أ$_5$ + 96 كجم بو$_2$أ / فدان .

المعاملات من رقم 6 الى 10 أخذت تسميد حيوى منفرد بالفوسفورين فقط أو مع (صفر ، 25 ، 50 ، 75%) من مستوى الفوسفور الموصى به (64 كجم فو$_2$أ$_5$) وذلك بالإضافة الى النيتروجين والبوتاسيوم وقد تم إضافتهم بالمستوى القياسى الموصى به وهو 80 كجم ن + 96 كجم بو$_2$أ / فدان .

المعاملات من رقم 11 إلى 15 أخذت تسميد حيوى مختلط (نيتروبين + فوسفورين) فقط بدون أى اسمدة كيماوية أو مع (صفر ، 25 ، 50 ، 75%) من كلا من النيتروجين والفوسفور الموصى به (80 كجم ن ، 64 كجم فو$_2$أ$_5$ / فدان على التوالى) بالإضافة إلى البوتاسيوم وقد تم إضافته بالمستوى القياسى الموصى به (96 كجم بو$_2$أ / فدان).

معاملتى الكنترول رقم (16) وهو ما يتبعه المزارع بدون أسمدة حيوية مع اضافة سماد كيماوى (100%) بمعدل 80 كجم ن + 64 كجم فو$_2$أ$_5$ + 96 كجم بو$_2$أ / فدان والمعاملة رقم (17) كنترول بدون اضافة أى أسمدة كيماوية أو حيوية.

تم توزيع المعاملات ال17 بالحقل فى قطاعات كاملة العشوائية فى أربع مكررات.

وكانت النتائج المتحصل عليها كالآتى:

1- <u>النمو الخضرى :</u>

بيانات النمو توضح أن تلقيح البذور وجذور الشتلات بالنتروبين + الفوسفورين مع إضافة 4/3 كمية النيتروجين (60 كجم ن/فدان) + 4/3 كمية الفوسفور (48 كجم فو$_2$أ$_5$/فدان) الموصى بها + معدل ثابت هو 96 كجم بو$_2$أ/فدان (معاملة رقم 15) قد أعطت أعلى نمو معبرا عنه بطول النبات وسمك الساق وعدد الأوراق والمساحة الورقية ووزن النبات جاف يليها المعاملة رقم 16 وهى التى سمدت ب 100% من النيتروجين والفوسفور والبوتاسيوم ولكن بدون تسميد حيوى والمعاملة رقم 14 والتى لقحت نباتاتها بالنتروبين والفوسفورين معا مع التسميد بمعدل 50% من كمية النيتروجين والفوسفور الموصى بها. ولقد استمر هذا التأثير ثابتا خلال مرحلتى القياس (بعد 70 ، 100 يوم من الشتل) وفى موسمى الزراعة).

2- **<u>التركيب الكيماوى للأوراق والعرش:</u>**

أ- <u>النيتروجين والفوسفور والبوتاسيوم الممتص فى النمو الخضرى :</u>

أظهرت النتائج أن تلقيح النباتات بالنتروبين أو الفوسفورين كلا بمفرده أو مختلطين معا قد أدى إلى زيادة معنوية فى كمية النيتروجين والفوسفور والبوتاسيوم الممتص فى كل مراحل النمو ، وهذه الزيادة كانت معنوية وتدريجية مع الزيادة فى مستويات الإضافة من النيتروجين أو الفوسفور أو كلاهما من 25% إلى 50% وحتى 75% من كلا العنصرين.

لذلك فان أعلى معدل للامتصاص من النيتروجين والفوسفور والبوتاسيوم (بالأوراق أو السيقان) تم التحصل عليه من المعاملة رقم 15 والتى لقحت نباتاتها بالنتروبين والفوسفورين + التسميد ب 4/3 كمية النيتروجين + 4/3 كمية الفوسفور + بوتاسيوم ، فى كلا الموسمين وفى كلا مرحلتى النمو (70 يوم من الشتل ، 100 يوم من الشتل). كما أوضحت النتائج أن النباتات التى أخذت تسميد معدنى فقط

ب- <u>محتوى الأوراق من الكلوروفيل :</u>

لوحظ أن النباتات التى تم تلقيحها بمخلوط من النتروبين والفوسفورين مع تسميدها بمعدل (50 ، 75%) من كمية السماد النيتروجينى والفوسفاتى أظهرت أعلى محتوى من كلوروفيل أ ، ب والكلوروفيل الكلى وقد تساوت فى ذلك مع المعاملة التى سمدت بالأسمدة الكيماوية (ن ، فو ، بو) بمعدل 100% بدون اضافة اسمدة حيوية. كما لوحظ أن المعاملات التى لقحت نباتاتها بالتسميد الحيوى المنفرد (نتروبين فقط ، معاملة رقم 1) أو (فوسفورين فقط ، معاملة رقم 6) أو التسميد الحيوى المختلط (نتروبين + فوسفورين ، معاملة رقم 11) ولكن بدون اضافة اسمدة كيماوية قد أعطت زيادة معنوية فى الكلوروفيل (أ) والكلوروفيل الكلى وذلك بالمقارنة بالكنترول الذى لم يسمد كيماويا أو حيويا بينما لم توجد بينها أى فروق معنوية فى محتوى الأوراق من كلوروفيل (ب) ، وذلك فى كلا الموسمين.

3- <u>الازهار ونسبة العقد :</u>

كمتوسط للموسمين أدى تلقيح النباتات بالنتروبين والفوسفورين مع التسميد المعدنى ب 4/3 كمية النيتروجين والفوسفور الموصى بها (معاملة رقم15) إلى الإسراع من تفتح أول زهرة على النبات بحوالى 8 أيام كما ازدادت نسبة عقد الثمار من 30.8 إلى 65.9 % بالمقارنة بمعاملة الكنترول (رقم 17) وهى التى لم تسمد كيماويا أو حيويا . على حين لم تتفوق المعاملة رقم 15 معنويا عن المعاملة رقم 16 والتى لم تسمد حيويا ولكن سمدت فقط بمعدل 100% من النيتروجين والفوسفور الموصى به.

4- المحصول المبكر والكلى للنبات والفدان :

أظهرت النتائج أن تلقيح البذور وشتلات الفلفل بالنتروبين أو الفوسفورين أو بمخلوط منهما أدى الى زيادة كمية المحصول المبكر والكلى للنبات والفدان بالمقارنة بالكنترول (الذى لم يضاف له أى أسمدة كيماوية أو حيوية) وذلك فى كلا الموسمين.

أدى التلقيح بالنتروبين أو الفوسفورين منفردا أو مخلوط منهما مع التسميد بمعدل (صفر ، 25، 50%) من كمية النيتروجين والفوسفور الموصى بها الى زيادة تدريجية فى كمية المحصول المبكر والكلى فى حين لم يكن هناك فرق معنوى فى المحصول الكلى عند اضافة 50 أو 75 % من كمية النيتروجين والفوسفور المعدنى اللازم لتغذية الفلفل عند تلقيح البذور والشتلات بأى من النتروبين أو الفوسفورين منفردا.

وكنتيجة عامة فإن تلقيح البذور وجذور شتلات الفلفل بالنتروبين و الفوسفورين + التسميد بمعدل 4/3 كمية النيتروجين + 4/3 كمية الفوسفور + البوتاسيوم بمعدل ثابت (المعاملة رقم 15) قد أعطت أعلى محصول مبكر وكلى للنبات والفدان مقارنة بباقى المعاملات وفى كلا الموسمين. وقد بلغت نسبة الزيادة فى المحصول المبكر للفدان 7.14 - 10.58% وفى المحصول الكلى للفدان 4.42 - 4.53% فى الموسمين بالمقارنة بمعاملة الكنترول التى سمدت معدنيا فقط بمعدل 100% من النيتروجين والفوسفور والبوتاسيوم مع عدم التلقيح بالأسمدة الحيوية فى كلا الموسمين. وقد أدت هذه المعاملة رقم (15) ايضا الى زيادة المحصول المبكر للفدان بمعدل 1.6 ، 6.4 مرة وزيادة المحصول الكلى بمعدل 4.5 ، 4.9 مرة وذلك بالمقارنة بمعاملة الكنترول (رقم 17) بدون أى سماد حيوى أو معدنى فى كلا الموسمين .

5- جودة الثمار :

أوضحت النتائج أن النباتات التى لقحت بمخلوط من النتروبين والفوسفورين معا مع تسميدها بمعدل 75% من كمية النيتروجين والفوسفور الموصى بها أو اضافة 100% من النيتروجين والفوسفور بدون سماد حيوى (معاملات رقم 15، 16) قد أعطت أكبر القيم بالنسبة لطول وقطر الثمار ومتوسط وزن الثمرة مقارنة بباقى المعاملات وفى كلا الموسمين.

وفيما يتعلق بصفات الجودة الكيميائية للثمار فقد وجد أن النباتات التى أخذت تسميد معدنى فقط دون اى سماد حيوى (المعاملة رقم 16) أو النباتات التى أخذت نتروبين + فوسفورين + 4/3 نيتروجين + 4/3 فوسفور + بوتاسيوم (المعاملة رقم 15) أو النباتات التى أخذت نتروبين + فوسفورين + 2/1 نيتروجين + 2/1 فوسفور + بوتاسيوم (المعاملة رقم 14) ، قد أعطوا أعلى محتوى للثمار من الحموضة وفيتامين ج والمواد الصلبة الذائبة ، وذلك فى كلا الموسمين.

أما بالنسبة لمحتوى ثمار الفلفل من السكريات فقد وجد أن المعاملات أرقام (15 ، 16) قد أعطت أعلى محتوى من السكريات الغير مختزلة والكلية بدون فرق معنوى بينها ، وهذه النتيجة تعكس دور التسميد الحيوى بالنتروبين والفوسفورين والذى يقوم بتوفير 25% من كمية السماد النيتروجينى والفوسفاتى المعدنى اللازم لاحتياج النباتات مع تحسين صفات جودة للثمار.

الخلاصة :

توصى الدراسة بتلقيح بذور الفلفل عند زراعة المشتل وجذور الشتلات عند الشتل بمخلوط من التسميد الحيوى بالنتروبين و الفوسفورين معا مع التسميد باضافة 4/3 كمية النيتروجين والفوسفور الموصى بها (تعادل 60 كجم ن + 48 كجم فو $_2$أ$_5$ /فدان) علاوة على اضافة كمية ثابتة من البوتاسيوم بمعدل 96 كجم بو $_2$أ /فدان) حيث أدت هذه المعاملة الى الحصول على أعلى نمو خضرى مع زيادة كمية المحصول المبكر والكلى للفدان مع تحسين جودة الثمار فى نباتات الفلفل الحلو صنف كاليفورنيا وندر عند الزراعة فى أرض طينية صفراء وبذلك فإنه يمكن توفير 25% من الاحتياجات السمادية النيتروجينية والفوسفاتية المطلوبة للفلفل عن طريق التسميد الحيوى بإضافة النتروبين والفوسفورين معا.

(ب) التجربة الثانية :

الملخص العربي

" تأثير التسميد العضوى على النمو الخضرى والتركيب الكيماوى والازهار والمحصول وجودة ثمار الفلفل."

اشتملت هذه التجربة على 16 معاملة تهدف الى تقييم استجابة نباتات الفلفل صنف كاليفورنيا وندر للتسميد بأربع مصادر من السماد العضوى (سماد البيوجاز – السماد البلدى – سماد الدواجن – الاجروليج) بالتبادل مع أربع طرق لإضافة السماد كالتالى :

1- إضافة السماد العضوى بمعدل 60كجم ن/فدان بدون إضافة أى أسمدة معدنية.
2- إضافة السماد العضوى بمعدل 60كجم ن/فدان مع إضافة فوسفور وبوتاسيوم بمعدل ثابت.
3- إضافة السماد العضوى بمعدل 30كجم ن/فدان + 30كجم نيتروجين معدنى فى صورة سلفات نشادر مع إضافة مستوى ثابت من الفوسفور والبوتاسيوم.
4- إضافة 60كجم ن معدنى + الفوسفور والبوتاسيوم بمعدل ثابت هو 64كجم فو $_2$أ$_5$+ 96كجم بو $_2$أ /فدان (معاملة الكنترول).

وقد وزعت المعاملات فى قطاعات كاملة العشوائية فى أربع مكررات.

وكانت النتائج المتحصل عليها كالآتى:

1- <u>النمو الخضرى :</u>

بالنسبة لمصادر السماد العضوى فقد أدى التسميد بسماد البيوجاز إلى زيادة النمو الخضرى لنبات الفلفل من حيث ارتفاع النبات وعدد الأوراق والمساحة الورقية والوزن الطازج والوزن الجاف للنبات فى كلا الموسمين وذلك بالمقارنة بباقى المصادر العضوية أما بالنسبة لطرق الإضافة فقد تفوق تأثير كل من إضافة السماد النيتروجينى كله فى الصورة المعدنية مع مستوى ثابت من الفوسفور والبوتاسيوم أو إضافة 30كجم ن فى الصورة المعدنية + 30كجم ن فى الصورة العضوية بالإضافة إلى مستوى ثابت من الفوسفور والبوتاسيوم على باقى طرق الإضافة.

كما أوضحت نتائج التفاعل أن استخدام 30كجم نيتروجين عضوى على صورة سماد البيوجاز + 30كجم نيتروجين معدنى على صورة سلفات نشادر + الفوسفور والبوتاسيوم بمستوى ثابت أدى إلى الحصول على أحسن النتائج فى معظم صفات النمو الخضرى وخاصة بالنسبة للوزن الجاف للنبات وذلك مقارنة بجميع

2- **التركيب الكيماوى للأوراق والعرش:**

أ- **النيتروجين والفوسفور والبوتاسيوم الممتص فى النمو الخضرى :**

أدى استخدام سماد البيوجاز إلى زيادة الممتص من النيتروجين والبوتاسيوم يليه التسميد بسماد الدواجن يليه سماد الأجروليج ثم أعطى السماد البلدى أقل كمية من النيتروجين والبوتاسيوم الممتص وكان هذا الاتجاه هو السائد فى كلا الموسمين وفى كلا مرحلتى النمو.

أما بالنسبة لطرق الإضافة فقد وجد ان إضافة 30كجم نيتروجين معدنى + 30كجم نيتروجين عضوى بالإضافة إلى الفوسفور والبوتاسيوم بمستوى ثابت قد أعطت أعلى كمية ممتصة من النيتروجين والفوسفور مساوية للمعاملة التى سمدت بالنيتروجين كله فى الصورة المعدنية بالإضافة إلى الفوسفور والبوتاسيوم الموصى بهم وذلك كاتجاه عام فى كلا الموسمين، أما بالنسبة للبوتاسيوم الممتص فقد كان أعلى ما يمكن فى المعاملة التى سمدت ب 30كجم نيتروجين معدنى + 30كجم نيتروجين عضوى وذلك كاتجاه عام فى كلا الموسمين وفى كلا مرحلتى النمو.

أما بالنسبة لمعاملات التفاعل بين المصدر وطريقة الإضافة فقد وجد أن إضافة 50% من التسميد النيتروجينى على الصورة العضوية (30كجم ن) خاصة سماد البيوجاز أو سماد الدواجن + 50% من السماد النيتروجينى على الصورة المعدنية (30كجم ن) + الفوسفور والبوتاسيوم الموصى بهم ، أدى إلى زيادة معنوية فى كمية النيتروجين والفوسفور والبوتاسيوم الممتص فى عرش نباتات الفلفل ، وذلك بالمقارنة بإضافة كل الاحتياجات النيتروجينية (60كجم نيتروجين) فى الصورة العضوية أو المعدنية.

ب- **محتوى الأوراق من الكلوروفيل :**

أظهرت النتائج أن إضافة 60كجم ن فى الصورة العضوية من أى سماد مستخدم بدون إضافة اسمدة معدنية أدت إلى الحصول على أقل مستوى من كلوروفيل أ ، ب والكلوروفيل الكلى بالأوراق فى كلا الموسمين. كما أن إضافة 50% من النيتروجين فى الصورة العضوية (سماد البيوجاز – سماد بلدى – سماد الدواجن أو سماد الأجروليج) + 50% من النيتروجين فى الصورة المعدنية بالإضافة إلى

3- <u>الازهار ونسبة العقد فى :</u>

أدى استخدام 30كجم نيتروجين عضوى من أى صورة من الأسمدة العضوية المستخدمة فى هذه الدراسة + 30كجم نيتروجين معدنى + الفوسفور والبوتاسيوم ، إلى الحصول على أعلى نسبة عقد للثمار مع التبكير فى موعد تفتح الأزهار ويكون مساويا بذلك مع الكنترول الذى تم تسميده بمعدل 60كجم ن من الأسمدة المعدنية وفى كلا الموسمين.

4- <u>المحصول المبكر والكلى :</u>

وجد أن أفضل المصادر العضوية والتى أعطت أعلى محصول مبكر و محصول كلى للنبات تنازليا على الترتيب هى سماد البيوجاز ثم سماد الدواجن ثم سماد الأجروليج ثم السماد البلدى وذلك فى كلا الموسمين. وبالنسبة لطرق الإضافة فلقد وجد أن النباتات التى أخذت 60كجم كله من النيتروجين المعدنى + الفوسفور والبوتاسيوم أو التى أخذت 50% من النيتروجين فى الصورة العضوية + 50% من النيتروجين فى الصورة المعدنية بالإضافة الى الفوسفور والبوتاسيوم قد أعطت أعلى محصول مبكر وكلى (طن/فدان) بالمقارنة مع طرق الإضافة الأخرى و فى كلا الموسمين.

أما بالنسبة لمعاملات التفاعل فقد كانت أفضل المعاملات التى أدت إلى زيادة المحصول المبكر سواء للنبات أو للفدان هى التسميد بمعدل 30كجم ن معدنى + 30كجم ن عضوى على هيئة سماد بيوجاز أو سماد مخلفات الدواجن + الفوسفور والبوتاسيوم الموصى بهم وذلك فى كلا الموسمين ، وبخصوص المحصول الكلى فقد تفوقت المعاملة التى سمدت بمعدل 30كجم ن معدنى + 30كجم ن عضوى على صورة سماد البيوجاز + الفوسفور والبوتاسيوم الموصى بهم، على باقى المعاملات وفى كلا الموسمين ، فى حين أتت المعاملة التى أخذت 30كجم ن معدنى + 30 كجم ن عضوى على صورة سماد مخلفات الدواجن + الفوسفور والبوتاسيوم فى المرتبة الثانية وكانت متساوية بذلك مع معاملة الكنترول والتى أخذت 100% من النيتروجين والفوسفور والبوتاسيوم ، وعلاوة على ذلك فإن المعاملة التى أخذت نباتاتها 60كجم

5- جودة الثمار :

أظهرت النتائج أن استخدام 30كجم نيتروجين عضوى على صورة سماد البيوجاز + 30كجم نيتروجين معدنى + الفوسفور والبوتاسيوم الموصى بهم ، قد أعطت أكبر حجم للثمار ومتوسط وزن الثمرة وأعلى جودة للثمار من حيث التركيب الكيماوى (الحموضة – المواد الصلبة الذائبة – فيتامين ج) وذلك مقارنة بباقى المعاملات وفى كلا الموسمين، تلتها استخدام 30كجم نيتروجين عضوى على صورة سماد الدواجن + 30كجم نيتروجين معدنى + الفوسفور والبوتاسيوم الموصى بهم ، حيث أتت هذه المعاملة فى المرتبة الثانية. ومن جانب آخر فإن استخدام 50% من النيتروجين على صورة سماد الأجروليج أو السماد البلدى قد أعطى نتيجة أقل أو مساوية للكنترول من حيث جودة الثمار (الحموضة – فيتامين ج – المواد الصلبة الذائبة). وهذه النتيجة تؤكد التفوق الناتج عن استخدام 50% من النيتروجين على صورة سماد البيوجاز أو الدواجن.

أما بالنسبة لنتائج السكريات فقد أوضحت أن الزيادة فى كمية النيتروجين العضوى المضاف من 30كجم إلى 60كجم (وذلك على حساب تناقص النيتروجين المعدنى) يقلل محتوى الثمار من السكريات الغير مختزلة والسكريات الكلية ولكنه يؤدى إلى زيادة السكريات المختزلة فى الثمار ، كما أن أعلى محتوى من السكريات الغير مختزلة والكلية تم الحصول عليها فى ثمار النباتات التى سمدت ب 60كجم نيتروجين معدنى .

وعموما فإن استخدام 30كجم نيتروجين عضوى على صورة سماد البيوجاز + 30كجم نيتروجين معدنى + الفوسفور والبوتاسيوم الموصى بهم قد أعطى أعلى محتوى للثمار من السكريات الكلية ، وتبعها فى هذا التأثير المعاملة التى سمدت أخذت نباتاتها ب30كجم نيتروجين عضوى على صورة سماد الدواجن + 30كجم نيتروجين معدنى + الفوسفور والبوتاسيوم الموصى بهم فى كلا الموسمين.

6- محتوى ثمار الفلفل من العناصر الثقيلة :

وجد أن إضافة أى من المصادر العضوية المستخدمة فى هذه الدراسة (سماد الدواجن وسماد البيوجاز يليهم سماد الأجروليج ثم السماد البلدى) على الترتيب تنازليا يؤدى إلى زيادة التركيز من العناصر الثقيلة (الرصاص – النيكل – الكادميوم) فى ثمار الفلفل ، كما أن إضافة كل كمية النيتروجين فى الصورة العضوية بالإضافة إلى الفوسفور والبوتاسيوم الموصى بهم قد أعطى أعلى تركيز من العناصر الثقيلة بالثمار وفى كلا الموسمين ، بينما أدى استخدام كل كمية النيتروجين على الصورة المعدنية إلى الحصول على أقل القيم لتركيز العناصر الثقيلة بالثمار.

وفى هذا المجال كانت المعاملة التى سمدت بمعدل 60كجم ن عضوى فى صورة مخلفات الدواجن + فوسفور وبوتاسيوم ، هى أعلى المعاملات فى نسبة تراكم النيكل والرصاص والكادميوم بالثمار، بالرغم من أن هذا التركيز مازال أقل من الحد الحرج.

الخلاصة :

توصى الدراسة بتطبيق التسميد بمعدل 30كجم نيتروجين عضوى على صورة سماد البيوجاز + 30كجم نيتروجين معدنى (فى صورة سلفات النشادر) + الفوسفور والبوتاسيوم بالمعدل الموصى به (64كجم فو2أ5 + 96كجم بو2أ /فدان) وذلك للحصول على أعلى نمو خضرى وأكبر كمية من المحصول المبكر والكلى وأحسن جودة لثمار نباتات الفلفل صنف كاليفورنيا وندر المنزرع فى أرض طينية صفراء .

الخلاصة :

توصى الدراسة بتلقيح بذور الفلفل عند زراعة المشتل وجذور الشتلات عند الشتل بمخلوط من التسميد الحيوى بالنتروبين و الفوسفورين معا مع التسميد باضافة 4/3 كمية النيتروجين والفوسفور الموصى بها (تعادل 60 كجم ن + 48 كجم فو2أ5 /فدان) علاوة على اضافة كمية ثابتة من البوتاسيوم بمعدل 96 كجم بو2أ /فدان) أو التسميد بمعدل 30كجم نيتروجين عضوى على صورة سماد البيوجاز + 30كجم نيتروجين معدنى (فى صورة سلفات النشادر) + الفوسفور والبوتاسيوم بالمعدل الموصى به (64كجم فو2أ5 + 96كجم بو2أ /فدان) حيث أدت هذه المعاملة الى الحصول على أعلى نمو خضرى مع زيادة كمية المحصول المبكر والكلى للفدان مع تحسين جودة الثمار فى نباتات الفلفل الحلو صنف كاليفورنيا وندر عند الزراعة فى أرض طينية صفراء.

استجابة محصول الفلفل للتسميد العضوي والحيوي

ملخص

اجريت تجربتان حقليتان على الفلفل الحلو صنف كاليفورنيا وندر فى مزرعة الخضر بكلية الزراعة بمشتهر أثناء الموسم الصيفى لعامى 2000 & 2001 . وفى التجربة الأولى تم دراسة تأثير تلقيح البذور وجذور الشتلات بالنتروبين أو الفوسفورين منفرد أو مخلوط منهما معا بالتبادل مع اضافة (صفر، 25، 50، 75%) من مستوى النيتروجين أو الفوسفور الموصى به أو كلاهما معا. وكانت أفضل المعاملات هى عند التلقيح بالنتروبين + الفوسفورين مع 75% من كمية السماد النيتروجينى والفوسفاتى بالإضافة إلى كمية البوتاسيوم الموصى بها (60 كجم ن + 48 كجم فو$_2$أ$_5$ + 96 كجم بو$_2$ أ) ، حيث أعطت هذه المعاملة أعلى نمو ومحصول وجودة لثمار الفلفل فى كلا الموسمين. وبذلك أمكن توفير 25% من السماد النيتروجينى والفوسفاتى عند التلقيح بالنتروبين والفوسفورين.

وفى التجربة الثانية درست استجابة نباتات الفلفل لأربع مصادر من السماد العضوى (سماد البيوجاز – السماد البلدى – سماد الأجروليج – سماد الدواجن) مع أربع طرق لإضافة النيتروجين. والنتائج أوضحت أن النباتات التى سمدت بمعدل 30كجم ن فى صورة سماد عضوى (بيوجاز) + 30 كجم ن معدنى (سلفات أمونيوم) بإضافة إلى معدل ثابت من الفوسفور والبوتاسيوم (64 كجم فو$_2$أ$_5$ + 96 كجم بو$_2$أ) ، قد أعطت أفضل نمو ومحصول وجودة لثمار الفلفل بالمقارنة بتلك التى سمدت بمعدل 60كجم ن كله فى الصورة المعدنية أو كله فى الصورة العضوية من جميع المصادر وكان ذلك الإتجاه فى كلا الموسمين.

استجابة محصول الفلفل للتسميد العضوي والحيوي

رسالة مقدمة من

عبدالحكيم سعد عبدالحكيم أحمد شمس

بكالوريوس فى العلوم الزراعية (شعبة البساتين)

من كلية الزراعة بمشتهر جامعة الزقازيق (فرع بنها) 1998

للحصول على

درجة الماجستير فى العلوم الزراعية

البساتين (خضر)

وقد تمت مناقشة الرسالة والموافقة عليها

اللجنة

أ.د / محمد عبدالمجيد بدوى ....

أستاذ الخضر ورئيس قسم الخضر بكلية الزراعة/جامعة القاهرة

أ.د / محسن حسن السواح ....

أستاذ الخضر ووكيل كلية الزراعة بالزقازيق/ جامعة الزقازيق

أ.د / محمد السعيد زكى ....

أستاذ الخضر المتفرغ بكلية الزراعة بمشتهر/جامعة الزقازيق- فرع بنها

أ.د / محمد ربيع جبل ....

أستاذ الخضر و رئيس قسم البساتين بكلية الزراعة بمشتهر/جامعة الزقازيق- فرع بنها

أ.د / نادية سعد شفشق ....

أستاذ الخضر بكلية الزراعة بمشتهر/جامعة الزقازيق- فرع بنها

تاريخ الموافقة :   /   / 2003

استجابة محصول الفلفل للتسميد العضوي والحيوي

رسالة مقدمة من

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من كلية الزراعة بمشتهر جامعة الزقازيق (فرع بنها) 1998

للحصول على

درجة الماجستير فى العلوم الزراعية

البساتين (خضر)

لجنة الاشراف العلمى

أ.د / محمد السعيد زكى

أستاذ الخضر المتفرغ بكلية الزراعة بمشتهر/جامعة الزقازيق- فرع بنها

أ.د / محمد ربيع جبل

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أ.د / نادية سعد شفشق

أستاذ الخضر بكلية الزراعة بمشتهر/جامعة الزقازيق- فرع بنها

قسم البساتين

كلية الزراعة بمشتهر – جامعة الزقازيق/فرع بنها

2003

استجابة محصول الفلفل للتسميد العضوي والحيوي

رسالة مقدمة من

عبدالحكيم سعد عبدالحكيم أحمد شمس

بكالوريوس فى العلوم الزراعية (شعبة البساتين)

من كلية الزراعة بمشتهر جامعة الزقازيق (فرع بنها) 1998

للحصول على

درجة الماجستير فى العلوم الزراعية

البساتين (خضر)

قسم البساتين
كلية الزراعة بمشتهر – جامعة الزقازيق/فرع بنها

2003