

Responses of Productivity and Quality of Cucumber to Application of the Two Bio-Fertilizers (Humic Acid and Nitroxin) in Fall Planting

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Abstract: Bio-fertilizers are low cost renewable source of plant nutrients which supplement chemical fertilizers. In this study, researchers determine the influence of exogenously applied two bio-fertilizers humic acid and nitroxin on morphological characteristics, fruit yield and quality of cucumber grown under direct soil conditions in a fall planting. The experiments were carried out in a factorial trial based on completely randomized block design with three replicates. The treatments were foliar application of humic acid at 0, 10, 20 and 30 mL⁻¹ and nitroxin at 0, 10, 20 and 30 mL⁻¹. Humic acid and nitroxin spray started in two true leaf stages for 3 times. The results showed that all humic acid and nitroxin treatments had significant effects on growth, yield and chemical characteristics including: Number of leaf/plant DM(%) plant, fruit diameter and length, fruit yield ha⁻¹. Also, fruit quality such as fruit firmness, total soluble sugars, fruit skin total chlorophyll, fruit skin chlorophyll a, fruit skin chlorophyll b were affected by bio-fertilizers (humic acid and nitroxin). Spraying with humic acid 30 mL⁻¹ can be a suitable treatment for enhancing growth and yield of cucumber plant.

Key words: Bio-fertilizer, cucumber, fall planting, humic acid, nitroxin, Iran

INTRODUCTION

Cucumber (*Cucumis sativus* var. *sativus*) is one of the important vegetable crops in Cucurbitaceae family. Cucumber is an important vegetable crop for human nutrition in the world (Alpaslan and Gunes, 2001). Cucumbers were consumed in Western Asia, Greece and ancient Egypt as long as 3000 years (Elmhirst, 2006). Excessive use of chemical fertilizers in agriculture causes environmental problems including soil, physical destruction and nutrient imbalance (Wang *et al.*, 1999). To improve the organic contents of soils for growing crops, there are some applications such as planting rotation, biological fertilizer application, green fertilizer application and animal fertilizer application. Humic acid are fraction of the complex mixture known as humic substances or Natural Organic Matter (NOM). These large molecular biopolymers are built during the degradation of organic material and are defined on their solubility in either acid or alkali. Humic acid with provide organic macromolecules has important role in the transport, bioavailability and solubility of heavy metals. Organic matters are fundamental in soil but dynamic component of soils that influences the many chemical, physical and biological properties that regulate soil productivity. Humic substances such as humic acid is the main components

(65-70%) of soil organic matter which cause increase plant growth enormously due to increasing cell membrane permeability, respiration, photosynthesis, oxygen and supplying root cell growth (Russo and Berlyn, 1990). Humic acid has a beneficial effects on plant growth may be related to their indirect (increase of fertilizer efficiency or reducing soil compaction) or direct (improvement of the overall plant biomass) effects.

In particular, the increase of root growth is generally more apparent than that of the shoot (Nardi *et al.*, 2002). It was reported that humic substances can have an effect on plants by influencing several physiological processes such as hormonal bio-stimulation (Nardi *et al.*, 2002). Obsuwan reported that application of humic acid increased fresh and dry weight in eggplant seedling. Rengrudkij and Partida (2003) reported humic acid increased the growth characteristics in avocado seedling. Habashy and Laila (2005) concluded that plant growth and yield of wheat crop were increased by fertilization with humic acid at 100 ppm. Gulser *et al.* (2010) studied the effect of humic acid on seedling growth in pepper under saline stress and reported that humic acid at (mg kg⁻¹) enhanced the growth characteristics significantly with compared to control. El Sayed *et al.* (2011) studied the effect of humic acid on productivity and quality of sweet potato and reported that humic acid

increased the growth parameter and yield in compared to control. Celik *et al.* (2010) reported that humic acid application enhanced the growth and nutrient uptake in maize. Humic acid increased the yield in wheat (Ulukan, 2008). Nitroxin is a biologic nitrogen fertilizer containing Azospirillum and Azotobacter (Azarpour *et al.*, 2012). Azospirillum belongs to family Spirilaceae, heterotrophic and associative in nature. In addition to their nitrogen fixing ability of about 20-40 kg ha⁻¹, they also produce growth regulating substances (Arun, 2007). Sharify and Haghnia studied the effect of nitroxin on wheat and reported nitroxin had the positive effect on plant height, number of seed/plant and yield. Bozorgi *et al.* (2011) with study effects of bio, mineral nitrogen fertilization and foliar zinc spraying on yield and yield components of faba bean were reported that the highest grain yield was obtained by 30 kg ha⁻¹ pure nitrogen along with seeds inoculation with nitroxin. Azarpour *et al.* (2012) reported that application of nitroxin enhanced the growth parameter and yield in soybean. Carletti (2002) studied the effect of Azotobacter as a growth inducing bacteria on maize yield and found that soil inoculation with this bacteria maximized N and P uptake potential and led to a considerably increase in yield. The current study aim was to investigate the influence of bio-fertilizer (humic acid and nitroxin) in growth and yield in cucumber.

MATERIALS AND METHODS

To study the effect of humic acid and nitroxin on growth and yield in cucumber (*Cucumis sativus* var. *sativus*) an experiment was conducted at Agricultural Research Station in Ferdowsi University of Mashhad, Mashhad Iran during Summer and Autumn, 2011. The cultivar employed in this experiment was Zina. NPK (20:20:20) was applied uniformly to the plots before planting. Seeds were sown directly in farm on 22 August 2011, in rows 75 cm apart with intra-row spacing of 35 cm. Each plot consisted of 10 plants. Plants were foliar-sprayed 3 times after two leaf stage with different concentrations of humic acid (0, 10, 20 and 30 mL⁻¹ and nitroxin (0, 10, 20 and 30 mL⁻¹), plants sprayed with distilled water served as the control (0 mL⁻¹ humic acid

and 0 mL⁻¹ nitroxin). Leafs surface of plants were totally wetted with humic acid solutions in order to accomplish faster and more effective absorption of humic acid during late afternoon. The experiment was set up in a randomized complete block design with three replications (10 plants per replication). Fruit harvested at the time of marketability from September 17 to October 16 in 2011. At flowering stage number of leaf and DM(%) of plant were counted. After harvest, fruit diameter, fruit height, mean fruit weight, fruit firmness, total yield, fruit skin total chlorophyll, fruit skin chlorophyll a and fruit skin chlorophyll b were determined. Firmness was measured for 6 fruits from each sample employing a hand penetrometer. Measurements were taken on opposite cheeks at the center of each fruit. Total sugar were measured by refractometer. Total chlorophyll, fruit skin chlorophyll a and fruit skin chlorophyll b were determined by spectrophotometer.

Statistical analysis: The experiment was carried out in a factorial trial based on completely randomized design, with three replicates. ANOVA was run for the variables by SAS 9.2 software and the Least Significant Difference (LSD) test was used to separate the means at <0.05. The charts were drawn in Excel 2010.

RESULTS AND DISCUSSION

The effects of humic acid and nitroxin treatments on yield and quality characteristics of cucumber fruit are shown in Table 1 and 2. Foliar humic acid and nitroxin treatments significantly increased the cucumber fruit yield.

Growth and yield characteristics: The result indicated that humic acid and nitroxin had significantly effect on growth characteristics with compared to the control. Humic acid at 30 mL⁻¹ enhanced the number of leaf per plant (14.11) and had significant different with other treatments (Table 1). Humic acid application lead to increasing uptake of micro elements that increase root growth and especially effective in increasing the number of leaves. These results are consistent to Celik *et al.* (2010),

Table 1: Growth and yield characteristics of cucumber fruit in response to foliar fertilization with various concentrations of humic acid and nitroxin

| Bio-fertilizer treatments (mL L ⁻¹) | No. of leaf/plant | DM plant (%) | Mean fruit weight (g) | Fruit diameter (mm) | Fruit length (cm) | Yield (kg ha ⁻¹) |
|---|---------------------|---------------------|-----------------------|---------------------|--------------------|------------------------------|
| Control | 10.210 ^d | 16.12 ^d | 89.11 ^d | 3.20 ^a | 13.52 ^f | 51420 ^e |
| Humic acid 10 mL L ⁻¹ | 12.120 ^c | 16.67 ^c | 91.50 ^{ab} | 2.93 ^a | 14.29 ^e | 55700 ^d |
| Humic acid 20 mL L ⁻¹ | 13.350 ^b | 17.52 ^b | 91.12 ^b | 2.67 ^b | 16.05 ^a | 65700 ^b |
| Humic acid 30 mL L ⁻¹ | 14.110 ^a | 18.10 ^a | 93.13 ^a | 2.42 ^c | 17.55 ^b | 73500 ^a |
| Nitroxin 10 mL L ⁻¹ | 12.250 ^c | 16.35 ^{cd} | 88.47 ^{cd} | 2.75 ^b | 15.12 ^d | 54420 ^d |
| Nitroxin 20 mL L ⁻¹ | 13.510 ^b | 16.58 ^c | 90.90 ^c | 2.52 ^c | 15.89 ^c | 61480 ^c |
| Nitroxin 30 mL L ⁻¹ | 13.570 ^b | 16.71 ^c | 91.25 ^{bc} | 2.50 ^c | 16.47 ^b | 65300 ^b |

Means followed by the same letters are not significantly different at the 5% level of significance

Table 2: Chemical composition of cucumber fruit in response to foliar fertilization with various concentrations of HA and nitroxin

| Bio-fertilizer treatments (mL L ⁻¹) | Fruit firmness (N) | Total soluble sugars (mg g ⁻¹) | Fruit skin chlorophyll a (µg mg ⁻¹) | Fruit skin chlorophyll b (µg mg ⁻¹) | Fruit skin total chlorophyll (µg mg ⁻¹) |
|---|---------------------|--|---|---|---|
| Control | 12.54 ^e | 115.72 ^b | 3.95 ^{bc} | 3.72 ^{bc} | 7.88 ^d |
| humic acid 10 mL L ⁻¹ | 13.23 ^d | 118.96 ^b | 4.20 ^b | 4.20 ^{ab} | 8.47 ^b |
| humic acid 20 mL L ⁻¹ | 14.01 ^b | 132.53 ^a | 4.08 ^b | 3.76 ^{bc} | 7.86 ^d |
| humic acid 30 mL L ⁻¹ | 13.72 ^c | 128.11 ^a | 5.23 ^a | 4.50 ^a | 9.77 ^a |
| Nitroxin 10 mL L ⁻¹ | 12.45 ^{cd} | 123.20 ^{ab} | 4.02 ^{bc} | 3.66 ^c | 7.71 ^d |
| Nitroxin 20 mL L ⁻¹ | 14.70 ^a | 117.91 ^b | 4.11 ^b | 4.02 ^b | 8.15 ^c |
| Nitroxin 30 mL L ⁻¹ | 13.03 ^d | 122.18 ^{ab} | 4.21 ^b | 4.11 ^b | 8.37 ^b |

Means followed by the same letters are not significantly different at the 5% level of significance

Russo and Berlyn (1990) and Nardi *et al.* (2002). The application of humic acid lead to increasing nutrient uptake of bent grass plant and increased the accumulation of dry materials. All bio-fertilizer treatments improved the DM(%) of vine (Table 1). The maximum of plant DM(%) was found in humic acid on 30 mL L⁻¹. Bio-fertilizer increased the photosynthesis in plant that laed to improvement in plant materials and dry weight. Fruit diameter and length were impressed by bio-fertilization. All humic acid and nitroxin treatments improved the fruit shape and marketability of cucumber significantly with compared to the control (Table 1). Humic acid at 30 mL L⁻¹ enhanced fruit length to 17.55 cm. Similar results were also presented by Karakurt *et al.* (2009), Ozdamar Unlu *et al.* (2011) and Pourkhaneghah *et al.* (2012). The result indicated that the application of bio-fertilizers enhanced mean fruit weight significantly compared to control (Table 1). The maximum mean fruit weight (100.13 g) was found in humic acid at 30 mL L⁻¹ treatment. The maximum number of fruit/plant (18.16 g) was found in humic acid at 30 mL L⁻¹ treatment (Fig. 1). These results are consistent to Khattak and Muhammad and Celik *et al.* (2010). The highest yield (73500 kg h⁻¹) was determined from humic acid foliar application at 30 mL L⁻¹.

All humic acid and nitroxin treatments improved the total yield of cucumber significantly with compared to the control (Table 1). This result was confirmed by Ozdamar Unlu *et al.* (2011) on cucumber, Pourkhaneghah *et al.* (2012) on maize, Karakurt *et al.* (2009) on peper. Humic acid induced increases in plant growth on sustainable basis are associated to its effect on root enzymes and rhizosphere soil. Humic acid and nitroxin leads to increased plant yield through positive physiological effects such as impact on metabolism of plant cells and increasing the concentration of leaf chlorophyll.

Chemical composition and quality: Total sugar content significantly was influenced by humic acid treatment (Table 2). The maximum total sugars (132.53 mg g⁻¹) were obtained from foliar 20 ml L⁻¹ application. Fruit skin chlorophyll content is a quality characteristic of cucumber fruit determining skin green color and thus

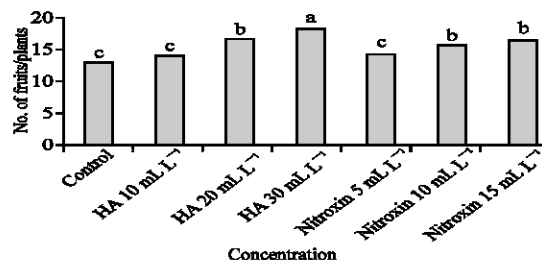


Fig. 1: Effect of foliar fertilization with various concentrations of humic acid and nitroxin on cucumber

influencing fruits appearance and consumer acceptance (Schouten *et al.*, 2002). Bio-fertilizers (Humic acid and nitroxin) treatments significantly improved the green color of cucumber fruit skin. The maximum total chlorophyll content was obtained from soil 30 mL L⁻¹ treatment. The change in total chlorophyll content in response to humic acid was mainly due to the change in chlorophyll a content since there was no significant effect of HA on chlorophyll b content. Both of chlorophyll a and b content showed a significant increase in response to both bio-fertilizers (Humic acid and nitroxin) treatments.

CONCLUSION

Humic acid and nitroxin foliar applications increased the cucumber fruit yield and quality. The results can be due to the reported enhancement in the growth of cucumber in response to the incorporation of humic acid into plant growth media (Russo and Berlyn, 1990; Nardi *et al.*, 2002; Atiyeh *et al.*, 2002; Ozdamar Unlu *et al.*, 2011). This stimulatory effect may have also been related to increased uptake of mineral nutrients reported earlier (Celik *et al.*, 2010) and the plant hormone-like activity of humic substances (Tattini *et al.*, 1990). Moreover, the positive influences of humic acids on the productivity and quality of cucumber could also be primarily due to hormone-like activities of the humic acid through their participation in cell respiration, photosynthesis oxidative phosphorylation, protein synthesis and various enzymatic

reactions (Heil, 2005). In general, application of humic acid and nitroxin can lessen the need for chemical fertilizers and subsequently reduce environmental pollution and compared with other chemical and bio-fertilizers, they are affordable.

Finally, it can be said that application of bio-fertilization humic fertilizer not only increases the yield of cucumber but also can play a significant role in achieving the goals of sustainable agriculture.

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