RESPONSE OF BEAN PLANT *Phaseolus vulgaris* L. TO SPRAY WITH HORNWORT EXTRACT AND NANO POTASSIUM ON GROWTH AND YIELD PARAMETERS

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Abstract

Field experiment was conducted in special farm kufa- alkizwinia area An-Najaf governorate during of 2018 in two season spring and autumn. The experiment included nine treatments, *i.e.* the interactions of three concentrations of hornwort extract (Shamplan) (first factor) (0, 10 and 20 ml L\(^{-1}\)) and nano-potassium (second factor) (0, 1.5 and 3 g L\(^{-1}\)) sprayed on vegetative. Sprays were applied third, first sprayed through four true leaves stages, second flowering initiation, third after two weeks from second sprayed. Factorial Design with in Randomized Complete Block Design (R.C.B.D.) was used with three replications. Means were compared according to Duncan’s Multiple Range Test (D.M.R.T.) at probability of 0.05. Results can be summarized as follows: 1- Using of concentrations of hornwort extract had a significant effect on measured vegetative growth parameters especially 20 ml L\(^{-1}\) (plant height and leaves number ) and yield parameters, yield per plant 395.5 and 253.1 g. plant\(^{-1}\), total yield gaves 8.742 and 5.618 ton.\(^{\text{H}-1}\) for both seasons, respectively, compared with control treatment, which gives the lowest average for the measured parameters included yield per plant 286.5, 178.1 g. plant\(^{-1}\) and total yield reach 6.362 and 3.952 ton.\(^{\text{H}-1}\) for both seasons, respectively. 20 ml L\(^{-1}\) gives the highest means for the chemical parameters (total chlorophyll, carbohydrate content in pod) for both seasons, respectively. 2- Using of concentrations of nano-potassium had a significant effect on measured vegetative growth parameters especial 3 g L\(^{-1}\) (plant height and leaves number) yield parameters (yield per plant 142.50 and 107.29 g. plant\(^{-1}\) and total yield 8.742 and 5.618 ton.\(^{\text{H}-1}\) for both seasons, respectively, compared with control treatment, which gives the lowest means for the measured parameters included yield per plant 265.6 and 133.7 g. plant\(^{-1}\), total yield 5.856 and 2.966 ton.\(^{\text{H}-1}\) for both seasons, respectively. 3- of nano-potassium gives the highest means for the chemical parameters (total chlorophyll and carbohydrate content in pod for both seasons, respectively . 3- interaction between experimental factors (20 ml L\(^{-1}\) hornwort extract X 3 g L\(^{-1}\) of nano-potassium) improvement of vegetative growth parameters (plant height and leaves number) and yield parameters (yield per plant 449.7 and 306.1 g. plant\(^{-1}\); total yield 9.990 and 6.797ton.\(^{\text{H}-1}\) for both seasons, respectively, compared with control treatment, which gave the lowest means for the measured parameters included yield per plant 203.7 and 83.0g. plant\(^{-1}\); total yield 4.520 and 1.840ton.\(^{\text{H}-1}\) for both seasons, respectively. 20ml L\(^{-1}\) hornwort extract and 3g L\(^{-1}\) of nano-potassium gave a highest means for the chemical parameters (total chlorophyll and carbohydrate content in pod for both seasons, respectively.

Key words: *Phaseolus vulgaris* L., hornwort, nano potassium

Introduction

The common bean *Phaseolus vulgaris* L. belongs to family Leguminosae (Fabaceae), which consist of about 600 genera and about 13000 species, and it is an important legume as dietary for more than 300 million someone in all the world, especially in developing nations, which with total production exceeding 23 million metric tons, seven million of which are produced in Latin America and Africa (Brought *et al.*, 2003). The common bean have nutrition value *i.e.* protein, lipid, calcium, iron, phosphorus, vitamins (A, B1, B2, B6, C) (Ware and Mccollum, 1980). The United Nations FAO reported that the world production of common bean was 23595714 tones and Iraq production was 4610 tones (FAO, 2018).

Foliar application is the most efficient method to increase yield and vegetative parameters. Results have shown that foliar feeding can increases yields from 12% to 25% when compared to conventional fertilization (Hussien *et al.*, 2012). As the method of reducing the

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use of chemical fertilizers has been proposed in recent years, using new products in this field has been considered by producers and researchers. Using hornwort extract Ceratophyllum demersum L. as foliar fertilizers because contain many nutrition’s and organic compound. Nanotechnology as a leading science, tries to produce less harmful and more effective Nano based fertilizers.

Potassium is an essential plant nutrient, which is necessary for the plants in large amount and is supplied by the foliar fertilizer. Potassium is essential for many of physiological process such photosynthesis, respiration, pod formation, winter hardiness and disease resistance. (Shafeek, et al., 2013).

Thus, the aim of the experiment was to elucidate the effect of spraying hornwort extract, nano-potassium and their interactions to determine the best focus on improving plant growth and yield of plant.

Materials and methods

An experiment was conducted during the growing season of 2018 in kufa- alkizwinia are a, An-Najaf governorate. The experiment design was factorial within Randomized Complete Block Design (R.C.B.D.) The experiment included 9 treatments i.e. the interaction of three concentrations of hornwort extract (Shamplan) (0, 10 and 20 ml.L⁻¹) and three concentrations of nano-potassium (0, 1.5 and 3 g.L⁻¹) Sprays were applied third, first sprayed through four true leaves stages, second flowering initiation, third after two weeks from second sprayed. Planting seeds in 10/3/2018 in spring cultivation and 1/9/2018 in autumn cultivation, distance between plants (25) cm. Irrigation was done by dripping system. Cultural practices were done equally and when it is considered necessary e.g. cultivation, weeding, etc. as mentioned in (Matlob et al., 1989). Duncan multiple range test was used to compare means when it is considered significant at probability of 0.05 (Al-Rawi and Khalaf-Allah, 2000), studied parameters were taken as follows:

Vegetative growth parameters: This included the following:

- Plant length (cm)
- Leaves number (leaf.plant⁻¹)

Yield and chemical parameters: This included the following:

- Yield per plant was calculated according the equation:
- Yield per Plant(g.plant⁻¹)= Experiment unit yield / Number of plants in experiment unit

Total yield: The cumulative yield was calculated for all plants harvested for each experimental unit until the end of the experiment as following:

- Experiment unit yield = yield Plant × Number of plants in experiment unit
- Total yield (ton.H⁻¹) = Experiment unit yield × area hectare (10000) m² /Experiment unit area
- Total Chlorophyll in Leaves (mg.100g⁻¹ fresh weight): By using acetone to extract chlorophyll pigment. According to (Mackinney, 1941)
- Content of the pods of carbohydrates (g.kg⁻¹): According to (Herbert et al., 1971).

Results

Results in Table 2, 3 revealed that, there were a significant differences between the treatments of hornwort extract. Treatment of 20 ml.L⁻¹ gave the highest value of vegetative growth parameters: Plant length and leaves number they were 41.81, 34.51 cm and 32.62, 25.36 leaf. plant⁻¹, for both seasons, respectively compared to the control treatment, which gave the least means 33.93, 28.13 cm and 24.91, 19.52 leaf. plant⁻¹, for spring and autumn seasons, respectively.

Nano-potassium spraying with con. 3ml.g⁻¹ clearly influenced on vegetative growth parameters: Plant length and leaves number were 40.72, 34.58 cm and 32.73, 25.08 leaf.plant⁻¹ for spring and autumn seasons, respectively, compared with control treatment (without spraying of nano-potassium), that gained the least values 35.13, 28.36 cm and 23.47, 19.47 leaf.plant⁻¹ for both seasons, respectively.

Table 1: Analysis of soil sample in the field experimental.

<table>
<thead>
<tr>
<th>Season</th>
<th>Type of Sample</th>
<th>Soil texture</th>
<th>EC ds.m⁻¹</th>
<th>pH</th>
<th>ppm</th>
<th>Mm.L⁻¹</th>
<th>Organic Materials %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P</td>
<td>N</td>
<td>K⁺</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.1</td>
<td>7.4</td>
<td>2.45</td>
</tr>
<tr>
<td>Spring</td>
<td>soil</td>
<td>Silty loam</td>
<td>1.7</td>
<td>7.0</td>
<td>2.16</td>
<td>1.81</td>
<td>0.76</td>
</tr>
<tr>
<td>autumn.</td>
<td>soil</td>
<td>Silty loam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Component of Hornwort extract.

| Component of Hornwort extract | N | 1.65% | 102.82 ppm | Glutamic acid | P | 0.26% | 4301.57 ppm | Serine | K | 0.39% | 528.16 ppm | Glysine | Ca | 3.73% | 9266.15 ppm | Threonine | IAA | 124.6 ppm | 898.86 ppm | Valine | GA | 30.28 ppm | 151.37 ppm | Tryptophane | Cytokinin | 180.88 ppm | 654.72 ppm | Phenylalanine | 361.91 ppm | Vitamin C |

Table 3: Content of the pods of carbohydrates (g.kg⁻¹).
The interaction between both factors appeared significant differences on all vegetative growth parameters: Plant length and leaves number. Treatments of (20 mL L\(^{-1}\) of hornwort extract and 3 mL L\(^{-1}\) nano-potassium) gave the highest values were 46.37, 38.23 cm and 36.80, 30.03 leaf plant\(^{-1}\) for both seasons, respectively. While, treatment of (0 hornwort extract X 0 nano-potassium) gave the lowest values of 32.40, 24.40 cm and 19.93, 18.70 leaf plant\(^{-1}\) for both seasons, respectively.

**Table 4:** Effect of hornwort extract and nano potassium on growth, yield and chemical parameters in common bean plant of 2018 in spring season.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Concentration</th>
<th>Plant length (cm)</th>
<th>Leaves number (leaf. plant(^{-1}))</th>
<th>yield per plant (g plant(^{-1}))</th>
<th>plant total yield (ton.h(^{-1}))</th>
<th>Total chlorophyll (mg.100g fresh weight)</th>
<th>Carbohydrate content in pod (g.kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hornwort extract (mg.L(^{-1}))</td>
<td>0</td>
<td>33.93c</td>
<td>24.91b</td>
<td>286.5b</td>
<td>6.362b</td>
<td>25.00c</td>
<td>20.02B</td>
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<td></td>
<td>10</td>
<td>38.08b</td>
<td>26.82b</td>
<td>335.1ab</td>
<td>7.433ab</td>
<td>27.44b</td>
<td>22.25B</td>
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<tr>
<td></td>
<td>20</td>
<td>41.81a</td>
<td>32.62a</td>
<td>395.5a</td>
<td>8.742a</td>
<td>29.92a</td>
<td>25.50A</td>
</tr>
<tr>
<td>Nano potassium (g.L(^{-1}))</td>
<td>0</td>
<td>35.13b</td>
<td>23.47c</td>
<td>265.6b</td>
<td>5.856b</td>
<td>25.51b</td>
<td>20.33B</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>37.97ab</td>
<td>28.19 b</td>
<td>354.4a</td>
<td>7.871a</td>
<td>26.86b</td>
<td>22.45 ab</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>40.72a</td>
<td>32.73a</td>
<td>397.1a</td>
<td>8.811a</td>
<td>30.00a</td>
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<td>hornwort extract (mg.L(^{-1})) x Nano potassium (g.L(^{-1}))</td>
<td>0</td>
<td>32.40d</td>
<td>19.93d</td>
<td>203.7d</td>
<td>4.520d</td>
<td>23.40c</td>
<td>17.88 C</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>35.30bcd</td>
<td>24.17cd</td>
<td>316.3bc</td>
<td>7.023bc</td>
<td>24.60de</td>
<td>22.01bc</td>
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<tr>
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<td>3</td>
<td>34.10cd</td>
<td>30.63ab</td>
<td>339.7abc</td>
<td>7.543abc</td>
<td>27.00cd</td>
<td>20.16bc</td>
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<tr>
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<td>21.47d</td>
<td>245.1cd</td>
<td>5.443cd</td>
<td>24.60de</td>
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<td>28.33bc</td>
<td>358.3abc</td>
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<td>30.67abc</td>
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<td>29.00bc</td>
<td>348.0abc</td>
<td>7.603abc</td>
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<td>23.00bc</td>
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<td>32.07ab</td>
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<tr>
<td></td>
<td>3</td>
<td>46.37a</td>
<td>36.80a</td>
<td>449.7a</td>
<td>9.990a</td>
<td>33.00a</td>
<td>28.96 A</td>
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</table>

**Table 3:** Effect of hornwort extract and nano potassium on growth, yield and chemical parameters in common bean plant of 2018 in autumn season.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Concentration</th>
<th>Plant length (cm)</th>
<th>Leaves number (leaf. plant(^{-1}))</th>
<th>yield per plant (g plant(^{-1}))</th>
<th>plant total yield (ton.h(^{-1}))</th>
<th>Total chlorophyll (mg.100g fresh weight)</th>
<th>Carbohydrate content in pod (g.kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hornwort extract (mg.L(^{-1}))</td>
<td>0</td>
<td>28.13C</td>
<td>19.52c</td>
<td>178.1b</td>
<td>3.952b</td>
<td>24.66B</td>
<td>17.68B</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>32.22B</td>
<td>21.94b</td>
<td>198.8b</td>
<td>4.412 b</td>
<td>26.17A</td>
<td>18.03B</td>
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<tr>
<td></td>
<td>20</td>
<td>34.51A</td>
<td>25.36a</td>
<td>253.1a</td>
<td>5.618 a</td>
<td>26.83A</td>
<td>20.68a</td>
</tr>
<tr>
<td>Nano potassium (g.L(^{-1}))</td>
<td>0</td>
<td>28.36C</td>
<td>19.47c</td>
<td>133.7c</td>
<td>2.966 c</td>
<td>25.13B</td>
<td>17.24B</td>
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<tr>
<td></td>
<td>1.5</td>
<td>31.93B</td>
<td>22.28b</td>
<td>226.3b</td>
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<td>26.06ab</td>
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<td>25.08a</td>
<td>269.9a</td>
<td>5.993 a</td>
<td>26.47A</td>
<td>20.31a</td>
</tr>
<tr>
<td>hornwort extract (mg.L(^{-1})) x Nano potassium (g.L(^{-1}))</td>
<td>0</td>
<td>24.40E</td>
<td>18.70 c</td>
<td>83.0e</td>
<td>1.840 e</td>
<td>24.07C</td>
<td>15.46B</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>29.70D</td>
<td>19.67c</td>
<td>204.9ed</td>
<td>4.550 ed</td>
<td>24.60bc</td>
<td>17.23ab</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>30.30 cd</td>
<td>20.20c</td>
<td>246.2bcd</td>
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<td>4.947 bcd</td>
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<td>25.00b</td>
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<tr>
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<td>30.03a</td>
<td>306.1a</td>
<td>6.797 a</td>
<td>27.27A</td>
<td>21.74a</td>
</tr>
</tbody>
</table>
Results in Tables 3, 4 illustrated that a significant variance between the treatments of hornwort extract on yield, chlorophyll and carbohydrate content in pods were 395.5, 253.1 g. plant⁻¹; 8.742, 5.618ton. H⁻¹; 29.92, 26.83mg.100g⁻¹; 25.50, 20.68 mg. g⁻¹ for both seasons, respectively with spraying 20 ml.L⁻¹ of hornwort extract, compared with control treatment, which gives the lowest means were 286.5, 178.1g. plant⁻¹; 6.362, 3.952 ton.H⁻¹; 25.00, 24.66 mg.100g⁻¹; 20.02, 17.68 mg.g⁻¹ for both seasons, respectively.

Nano-potassium spraying had an increasing effect with con. 3 ml.L⁻¹ between the treatments on yield, chlorophyll and carbohydrate content in pods were 286.5, 253.1 g. plant⁻¹; 8.742, 5.618ton.H⁻¹; 30.00, 26.47 mg.100g⁻¹; 25.00, 20.31mg. g⁻¹ for both seasons, respectively, compared with treatment (without spraying of nano-potassium) that gives the lowest values were 265.6, 133.7g. plant⁻¹; 5.856, 2.966ton.H⁻¹; 25.51, 25.13 mg.100g⁻¹; 20.33, 17.24 mg. g⁻¹, respectively.

The interaction between both factors gave significant differences on yield, chlorophyll and carbohydrate content in pods. Treatments of (20 ml.L⁻¹ hornwort extract X 3 ml.L⁻¹ nano-potassium) gave the largest values 449.7, 306.1 g. plant⁻¹; 9.990, 6.797 ton.H⁻¹; 33.00, 27.27 mg.100g⁻¹; 28.96, 21.74 mg. g⁻¹ for both seasons, respectively. While, treatment of (0 hornwort extract X 0 nano-potassium) gave the lowest values 203.7, 83.0 g.planet⁻¹; 4.520, 1.840ton.H⁻¹; 23.40, 24.07mg.100g⁻¹; 17.88, 15.46 mg. g⁻¹ for both seasons, respectively.

**Discussion**

The results showed that spraying with the hornwort extract in combination with nano-potassium fertilizer had a “significant” effect on the increase in vegetative growth (plant height and number of leaves), yield traits and chemical parameters such chlorophyll and carbohydrate content in pods tables (3 and 4) respectively. The reasons of these effects could be attributed to hornwort extract spraying that had affected many physiological processes, Because it contains many essential nutrients (N, P, K) as shown in Table 2, which play an important role in the construction of important organic compounds in the physiological and biological processes within the plant, amino acids, nucleic acids, chlorophyll, proteins, hormones and important enzymes, which are involved in the process of building protoplasm, phospholipids and enzymatic accompaniments such as NAD and NADP, which are important in respiration and photosynthesis reactions, This in turn leads to an increase in the parameters above (Alsahaf, 1989). As well as the hornwort extract contain on some growth organizations as shown in Table 2 that increase the rate of cell division and increase the efficiency of the process of photosynthesis and the formation of pigments for light reactions and increase the rate of cell division and increase the efficiency of photosynthesis process (Thomas, 1982), and then increase the plant’s ability to manufacture food through the process of photosynthesis, which is reflected positively “in increasing the rates of vegetative growth, including the height of the plant and the number of leaves, which in turn lead to an increase in parameters of the yield, which reflects positively” on the total and the nutritional content of green pods, and the content of leaves of total chlorophyll.

The obtained results are in a good accordance with these recorded by Al- Amin (2018) who found that increasing hornwort extract levels increased plant growth characters and yield in cucumber *Cucumis sativus* L. plant.

The reason for the significant increase in the use of nano-potassium fertilizer due to important effect of the potassium nutrient as it works to activate more than 60 enzymes important in metabolic processes and has an important role in the operations of opening and closing the stomata and the transfer of carbohydrates manufactured in the leaves to the rest of the plant parts (Devlin and Witham, 1986). As well as “help in the processes of the formation of proteins and nucleic acids and photosynthesis, which leads to an increase in the amount of processed food, which is reflected positively” in the increase parameters of vegetative growth and yield (Alsahaf, 1989).

Potassium nutrient very important in biochemical pathways in plants, where Potassium acts as an activator for several enzymes involved in carbohydrates metabolism (Taiz and Zeiger, 2006). The obtained results are in a good accordance with these recorded by Hasaneen et al., (2016) who found that increasing potassium fertilizer levels increased plant growth characters and yield in common bean plant.

**References**


