Effect of Concentration and Period of Seed Soaking with Atonik on Some Quantitative Traits of Mung Bean

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Abstract. A field experiment was carried out during spring season of 2016 and 2017 in the field of the Department of Field Crops - College of Agriculture - University of Anbar (Alternative Site – Abu Ghraib), to study the effect of concentration and Period of seed soaking with the Atonik growth regulator on the some quantitative traits of the mung bean (Al-Khadhrawi variety). Split plots arrangement according to randomized complete block design (RCBD) at three replications was used. The concentrations of soaking with Atonik (0, 2.5, 5- and 7.5-ml L\(^{-1}\)) were the main plots, while the soaking period (0, 2, 4 and 6 hours) occupied the sub plots. The results showed that the seeds soaking with Atonik growth regulator at a 7.5 ml L\(^{-1}\) recorded the highest plant height (54.05 and 47.10 cm), number of pods (15.83 and 11.58 pods plant\(^{-1}\)) and number of seeds (10.81 and 8.48 seeds pod\(^{-1}\)) for both seasons respectively, and number of branches (14.33 branch plant\(^{-1}\)) in the first season only. The soaking period for 6 hours was significantly superior and gave the highest plant height (54.23 and 46.59 cm), number of branches (14.00 and 12.80 plant branch\(^{-1}\)), number of pods (16.75 and 14.08 pod plant\(^{-1}\)) and number of seeds (10.80 and 8.80 seed pod\(^{-1}\)) for both seasons respectively. The interaction between concentrations of soaking at 7.5 ml L\(^{-1}\) and soaking period for 6 hours had highest values for more the studied traits and both seasons. We can bw conclude that the quantitative characteristics of the mung It can be improved by using seed soaking treatment before planting with Atonik growth regulator.

1.Introduction
Mung bean (\textit{Vigna radita} L.) is one of the summer leguminous crops that are widely cultivated in all regions of Iraq. The crop is characterized by a short growing season (90-120 days) and its tolerance to drought conditions in all stages of its growth except for the flowering stage [1]. The crop is grown for the purpose of obtaining its seeds of high nutritional value for humans and animals, because they are rich in nutrients, protein (29%) and carbohydrates (65%), and oil (1.5%). Mung bean is also used as green fodder for animal feed, in addition to its use as green manure to improve the natural properties of the soil [2]. It is one of the crops in warm regions and can be planted more than once a year, and it is included in the crop rotation system due to the possibility of planting it after the wheat crop for its role in reactivating the soil depleted by wheat [3]. Despite the importance of the crop in nutrition and its fertility benefits to the soil, the cultivated areas in Iraq are still low, as the area planted with the mung bean crop is estimated at about 542 hectares, with a production rate of 1154 Kg ha\(^{-1}\) [4]. Therefore, it became imperative for researchers and specialists in crop production and seed technology to find the means to raise the
productivity of mung bean per unit area. The technology of seeds soaking with plant growth regulators and nutrients before planting is one of the most important methods that have proven its effectiveness and through linking the soaking process with the basic processes of crop serving, especially improving the vegetative growth by imbibition the seeds with about 21% of their dry weight with these growth regulator solutions to start the metabolic processes of germination [5]. One of the growth regulators that contribute to increasing the efficiency of plant nutrition through the technology of soaking seeds at varying periods is the use of Atonik, it's a growth regulator of a liquid nature, with a dense dark brown color. Its components are nitro-aromatic compounds as much as 65 g L⁻¹, in addition to, its content of iron, manganese, sulfur, copper, zinc, calcium and molybdenum elements in a small amount. Atonik leads to increased root growth and formation of adventitious roots. It can quickly enter to plant tissues, affecting the plasma flow in cells and stimulate the growth [6]. [7] indicated that the Atonic growth regulator increases the absorption of nutrients by plants such as potassium, calcium and magnesium, which leads to raising the efficiency of the photosynthesis process and then increasing the seed yield. Therefore, this experiment was carried out to study the effect of concentration and period of seed soaking with Atonik on some quantitative traits of the *Vigna radiata* L. var. Al-Khadhrawi.

### 2. Materials and Methods

A field experiment was carried out during spring season of 2016 and 2017 in the field of the Department of Field Crops - College of Agriculture - University of Anbar (Alternative Site – Abu Ghraib) in a clay loam soil (pH: 7.13, Ec: 2.8 dS m⁻¹), to study the effect of concentration and period of seed soaking with the Atonik growth regulator on the some quantitative traits of the *Vigna radiata* L. var. Al-Khadhrawi. Split plots layout within randomized complete block design (RCBD) at three replications was used. The concentrations of soaking with Atonik (0[control] 2.5, 5- and 7.5-ml L⁻¹) were in the main plots, while the soaking period (0, 2, 4 and 6 hours) were in the sub plots. The seeds for 0 concentration treatment were soaked in water. Soil management were carried out, and then the experiment land was divided into experimental units, the area of each experimental unit was 6 m² (3 m x 2 m) which contained 8 lines, 50 cm apart and 25 cm between plants. The seeds of the mung bean were sown in 10 April 2016 and 15 April 2017 by placing 3-4 seeds per hill and thinned to one plant per hill after 10 days of germination. Nitrogen fertilizer was applied with an average 40 kg N ha⁻¹ as urea (46% N) with two equal split doses, the first dose was at planting and the second dose was at flowering stage, whereas the phosphorous fertilizer was used before planting with an average 75 Kg P₂O₅ ha⁻¹ as triple superphosphate fertilizer (46% P₂O₅) [8]. Crop management was carried out as needed. At harvest time, ten plants were randomly taken from each of experimental unit to study the plant height (cm), number of branches per plant, number of pods per plant, number of seeds per pod and pod length (cm). Data were statistically analyzed by using Gnestat program and least significant difference (LSD) test at 0.05 probability level was used to compare the treatment means.

### 3. Results and Discussion

#### 3.1. Plant height (cm): The results in table (1) show that the soaking of mung bean seeds with Atonik at a 7.5 ml L⁻¹ was significantly superior and achieved the highest plant height (54.05 and 47.10 cm) compared with control treatment (un-soaked seeds) which achieved the lowest plant height (47.47 and 42.43 cm) for 2016 and 2017 seasons respectively. The reason may be attributed to the role of Atonik in stimulating the growth of roots, which helps the plant to be more active to absorb nutrients, as well as Atonik can move easily within plant tissues, which affects the flow of plasma and cell sap and thus stimulate the vegetative growth [9 and 10]. Also, the results indicate that the soaking period for 6 hours was significantly superior and gave the highest plant height (54.23 and 46.59 cm) compared with control treatment which gave the lowest plant height (46.91 and 42.69 cm) for both seasons respectively. The interaction between two factors had a significant effect on this trait, the soaking seeds with Atonik at a 7.5 ml L⁻¹ for 6 hour had highest values (59.90 and 50.53 cm) while the control treatment (0 concentration for 0 hr) had lowest values (45.69 and c41.80 m) for both seasons respectively.
IOP Conf. Series: Earth and Environmental Science 904 (2021) 012070   doi:10.1088/1755-1315/904/1/012070

Table 1. Effect of concentration and period of soaking with Atonik on plant height(cm).

| Soaking Period (h) | Season of 2016 | Season of 2017 |
|--------------------|----------------|----------------|
|                    | Soaking seed (ml L\(^{-1}\)) | Mean | Soaking seed (ml L\(^{-1}\)) | Mean |
|                    | 0   | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 |
| 0                  | 45.69 | 46.82 | 47.56 | 47.59 | 46.91 | 42.59 | 43.02 | 42.20 | 42.96 | 42.69 |
| 2                  | 46.96 | 47.72 | 47.50 | 52.62 | 48.45 | 42.95 | 43.28 | 44.90 | 46.26 | 44.35 |
| 4                  | 48.56 | 49.01 | 52.71 | 56.10 | 51.62 | 41.80 | 44.00 | 47.40 | 48.66 | 45.46 |
| 6                  | 48.69 | 52.92 | 55.40 | 59.90 | 54.23 | 42.40 | 45.46 | 47.97 | 50.53 | 46.59 |
| LSD 0.05           | 2.03 | 1.09 | 3.35 | 1.03 |
| Mean               | 47.47 | 48.89 | 50.79 | 54.05 | 42.43 | 43.94 | 45.61 | 47.10 |
| LSD 0.05           | 1.02 |    |    | 1.01 |

3.2. Number of branches per plant (branch plant\(^{-1}\))
The results in table (2) indicate that the soaking of mung bean seeds with Atonik at a 7.5 ml L\(^{-1}\) was significantly superior and gave the highest number of branches (14.33 branch plant\(^{-1}\)) compared with 2.5 ml L\(^{-1}\) control treatment (un-soaked seeds) which gave the lowest values (12.00 branch plant\(^{-1}\)) in the first season only. The reason of an increase in branch per plant could be due to the role of the soaking period in the imbibition process which leads the activation of metabolic processes within the seed and improvement of germination and growth traits [12]. The interaction between two factors had a significant effect on this trait, the soaking seeds with Atonik treatment (un-soaked seeds) which achieved the lowest values (12.00 branch plant\(^{-1}\)) for both seasons respectively.

Table 2. Effect of concentration and period of soaking with Atonik on number of branches per plant (branch plant\(^{-1}\)).

| Soaking Period (h) | Season of 2016 | Season of 2017 |
|--------------------|----------------|----------------|
|                    | Soaking seed (ml L\(^{-1}\)) | Mean | Soaking seed (ml L\(^{-1}\)) | Mean |
|                    | 0   | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 |
| 0                  | 11.67 | 12.00 | 13.33 | 14.00 | 12.75 | 8.33 | 10.69 | 9.33 | 10.00 | 9.59 |
| 2                  | 11.00 | 12.00 | 13.33 | 12.67 | 12.25 | 9.66 | 10.32 | 10.00 | 11.32 | 10.33 |
| 4                  | 12.00 | 12.67 | 14.00 | 15.00 | 13.42 | 12.99 | 10.66 | 11.00 | 12.61 | 11.83 |
| 6                  | 13.33 | 13.00 | 14.00 | 15.67 | 14.00 | 12.33 | 13.00 | 13.21 | 12.66 | 12.80 |
| LSD 0.05           | 2.02 | 1.01 | 2.18 | 1.09 |
| Mean               | 12.00 | 12.41 | 13.67 | 14.33 | 10.83 | 11.17 | 10.88 | 11.66 |
| LSD 0.05           | 1.02 |    |    | N.S |

3.3. Number of pods per plant (pod plant\(^{-1}\))
The results in table (3) show that the soaking of mung bean seeds with Atonik at a 7.5 ml L\(^{-1}\) was significantly superior and gave the highest number of pods (15.83 and 11.58 pod plant\(^{-1}\)) compared with control treatment (un-soaked seeds) which gave the lowest number of pods (11.33 and 8.00 pod plant\(^{-1}\)) for both seasons respectively. The reason of an increase may be due to the role of growth regulators, including Atonik, in increasing the absorption of the necessary elements by the plant, which leads to an increase in cell division and elongation, thus an increase the plant height and number of branches per plant and then an increase in the number of pods per plant [13]. The results revealed that the soaking period for 4 hour in the first season and 6 hours in the second season was significantly superior and achieved the highest number of pods (16.75 and 14.08 pod plant\(^{-1}\)) compared with control treatment (un-soaked seeds) which achieved the lowest values (8.25 and 5.83 pod plant\(^{-1}\)) for both seasons respectively.
The reason of an increase may be attributed to the role of this treatment in directing growth factors towards increasing vegetative growth indicators such as plant height and number of branches per plant and increasing the amount of metabolic products and their transfer to the new sites (primordia) in the reproductive stage of the plant, which led to increase the flowering process and provide the essential nutrients for its growth and development and increase the fertility rate and then increase the number of pods per plant [12]. The interaction between two factors had a significant effect on this trait, the soaking seeds with Atonik at 7.5 ml L⁻¹ for 6 hour had highest values (20.33 and 16.00 pod plant⁻¹) while the control treatment (un-soaked seeds) had a lowest value (7.00 and 4.00 pod plant⁻¹) for both seasons respectively.

Table 3. Effect of concentration and period of soaking with Atonik on number of pods per plant (pod plant⁻¹).

| Soaking Period (h) | Season of 2016 |                  | Season of 2017 |                  |
|-------------------|---------------|-----------------|---------------|-----------------|
|                   | Soaking seed (ml L⁻¹) | Mean |                   | Soaking seed (ml L⁻¹) | Mean |
| 0                 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 |
| 0                 | 7.00 | 7.67 | 9.33 | 9.00 | 8.25 | 4.00 | 5.33 | 7.00 | 7.00 | 5.83 |
| 2                 | 9.00 | 12.00 | 14.00 | 15.00 | 12.50 | 6.00 | 8.33 | 9.33 | 7.58 |
| 4                 | 13.00 | 16.00 | 19.00 | 19.00 | 16.75 | 10.00 | 10.33 | 12.00 | 14.00 | 11.58 |
| 6                 | 16.33 | 19.00 | 9.00 | 20.33 | 16.17 | 12.00 | 13.33 | 15.00 | 16.00 | 14.08 |
| LSD 0.05 | 5.08 |                  | 3.45 |                  | 5.52 |                  | 3.26 |
| Mean | 11.33 | 13.67 | 12.83 | 15.83 | 8.00 | 8.92 | 10.58 | 11.58 |
| LSD 0.05 | 1.49 |                  | 1.33 |                  |  |                  |  |

3.4. Number of seeds per pod (seed pod⁻¹)

Soaking mung bean seeds in Atonik in table (4) at 7.5 ml L⁻¹ it could be noticed that there were significant differences in number of seeds per pod it recorded the highest adjective value (10.81 and 8.48 seed pod⁻¹). On the other hand, untreated seeds (control treatment) resulted the lowest adjective value (8.92 and 6.76 seed pod⁻¹) for both seasons respectively. The reason of an increase may be due to the role of Atonik in raising the efficiency of photosynthesis and increasing its products which may be increase the pollen germination, number of fertilized ovules and then an increasing the number of seeds per pod [10]. Also, the results indicate that the soaking period for 6 hours was significantly superior and gave the highest number of seeds (10.80 and 8.08 seed pod⁻¹) compared with control treatment (un-soaked seeds) which gave the lowest (9.08 and 5.81 seed pod⁻¹) for both season respectively. These results are in agreement with [14] who indicated that the activation period has an important role in seed imbibition and improvement of germination strength which positively reflected on the growth and yield indicators. The interaction between two factors had a significant effect on this trait, the soaking seeds with Atonik at 7.5 ml L⁻¹ for 6 hour had highest values (12.30 and 9.61 seed pod⁻¹) while the control treatment (un-soaked seeds) had lowest values (7.53 and 4.93 seed pod⁻¹) for both seasons respectively.

Table 4. Effect of concentration and period of soaking with Atonik on number of seeds per pod (seed pod⁻¹).

| Soaking Period (h) | Season of 2016 |                  | Season of 2017 |                  |
|-------------------|---------------|-----------------|---------------|-----------------|
|                   | Soaking seed (ml L⁻¹) | Mean |                   | Soaking seed (ml L⁻¹) | Mean |
| 0                 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 |
| 0                 | 7.53 | 9.66 | 9.60 | 9.53 | 9.08 | 4.93 | 5.40 | 5.73 | 7.20 | 5.81 |
| 2                 | 8.76 | 8.40 | 9.30 | 10.63 | 9.28 | 6.13 | 6.66 | 7.34 | 8.00 | 7.03 |
| 4                 | 9.23 | 9.47 | 10.73 | 10.80 | 10.06 | 7.80 | 8.27 | 6.85 | 9.60 | 8.80 |
| 6                 | 10.17 | 10.17 | 10.57 | 12.30 | 10.80 | 8.17 | 8.83 | 8.60 | 9.61 | 8.80 |
3.5. Pod length (cm)

The results in table (5) indicate that there was no significant effect of soaking concentrations and soaking period on pod length for mung bean. However, the interaction between two factors had a significant effect in this trait, the soaking seeds with Atonik at a 2.5 for 6 hour and 7.5 ml L\(^{-1}\) for 2 hour had highest values (8.94 and 8.10 cm) whereas the control treatment and the soaking seeds with Atonik at 2.5 for 2 hours had a lowest value (4.33 and 4.72 cm) for first and second season respectively.

| Soaking Period (h) | Season of 2016 | Soaking seed (ml L\(^{-1}\)) | Mean | Season of 2017 | Soaking seed (ml L\(^{-1}\)) | Mean |
|-------------------|---------------|-------------------------------|------|---------------|-------------------------------|------|
|                   |               | 0 | 2.5 | 5 | 7.5 | 0 | 2.5 | 5 | 7.5 |
| 0                 | 4.33          | 6.16 | 7.42 | 6.60 | 6.13 | 6.02 | 4.99 | 5.22 | 6.39 | 5.65 |
| 2                 | 5.03          | 6.50 | 7.53 | 6.13 | 6.30 | 5.75 | 4.72 | 7.62 | 8.10 | 6.55 |
| 4                 | 7.43          | 7.43 | 7.76 | 7.47 | 6.30 | 6.98 | 6.96 | 6.32 | 8.06 | 7.08 |
| 6                 | 8.30          | 8.94 | 8.43 | 8.10 | 8.44 | 5.73 | 6.90 | 6.79 | 7.53 | 6.74 |
| LSD 0.05          | 3.05          | N.S | N.S | N.S | 3.03 | N.S | N.S | N.S | N.S |
| Mean | 6.28 | 7.26 | 7.79 | 7.07 | 6.120 | 5.891 | 6.49 | 7.52 |

4. Conclusion

We concluded that the quantitative characteristics of the mung can be improved by soaking the seeds before planting with Atonik growth regulator at 7.5 ml L\(^{-1}\) for 6 hours as a result of giving them the highest results of the studied traits compared with other concentrations and periods of soaking.

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