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Response of snap bean growth and seed yield to seed size, plant density and foliar application with algae extract

Yehia I. Abu Seif [a,*], Salah El-Din M. El-Miniawy [b], Nashwa A.I. Abu El-Azm [b], Amal Z. Hegazi [a]

[a] *Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt*
[b] *Horticulture Dept., Faculty of Agriculture, Ain Shams University, Cairo, Egypt*

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Seed yield

Abstract Two field experiments were conducted during the two growing summer seasons of 2013 and 2014, at the experimental farm of vegetables at Kaha, Qalyubia Governorate, Agriculture Research Center (ARC), Egypt, in order to investigate the effect of seed size, plant density and foliar application with some algae extracts on growth and seed yield of snap bean cv. valentino. A split–split plot design was used with three replications, where three sizes i.e., large, small and control (without grading) were randomly distributed in the main plots, two plant density rates (22 and 33 plants per m^2) arranged in subplots and foliar spray with seaweed extract (algost), fresh water algae (spirulina), mixture of them and control (sprayed with distilled water) allocated in sub–sub-plots. Results showed a clear positively enhancement of plant vegetative growth parameters, chlorophyll, N, P, and K contents of leaves and seed yield quantity and quality positively by sowing large seeds compared with other seed sizes. Meanwhile, higher plant density (33 plants per m^2) gave the highest values of plant length and seed yield per feddan, while the lower plant density (22 plants per m^2) gave the highest values in other studied parameters except weight of 100 seeds where there were no significant differences between the two plant densities. All foliar applications with algae extracts significantly increased all the studied parameters compared to the control treatment. The superior application was the mixture of seaweeds and fresh water algae extracts together followed by seaweed extract alone in the two seasons, respectively.

Introduction

In Egypt, Snap bean (*Phaseolus vulgaris* L.) is cultivated mainly for green pods and secondary for seeds. Snap bean is a cash crop because most cultivated cultivars are short-term

* Corresponding author.
E-mail address: yehiaibrahim2020@yahoo.com (Y.I. Abu Seif).

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production for green pods yield. Also the short period for producing green pods makes the crop suitable for cultivation between main crops in the crop rotation. So, snap bean is an important vegetable crop for local consumption and exportation.

Snap bean cultivation in Egypt suffers from many problems finally led to minimizing either yield of green pods or seeds. There are many reasons for decline in growth and yielding of snap bean: 1- Snap bean propagates only via seeds so that its growth and subsequent yielding are affected with seed properties. 2- Most growers used to produce their own seeds by allowing the tail end of their crops to mature into seeds or by cultivating on a little area or obtaining the seeds from uncertified other farms. 3- Uncertified seeds are cheap, unknown quality attributes and often small sized because of repeating cultivation of less quality seeds and without applying practices of certification for production of high quality seeds.

Seed size is an important physical indicator of seed quality that affects vegetative growth and is frequently related to yield and the use of good quality seed is very essential which increases the yield by 15–20% (Ambika et al., 2014). Seed size can influence germination and subsequent development of plants to produce high yield. Also, El-Sawah (2007) and Nosser and Behnan (2011) found that sowing large (heavy) bean seeds gave the highest values in plant vegetative growth parameters and dry seed yield. In addition, heavy seeds positively affected chemical constituents' concentration of plants such as N, P, and K and seed quality of protein and total soluble carbohydrates. Generally, large seed is related to better agronomic aspects and thus has better field performance than small seed.

Also, plant densities i.e., number of plants per unit area are an important agronomic practice that can affect crop yield. Studies showed that there was a significant difference between different plant densities in terms of their effects on traits such as number of pods per plant, number of grains per plant, number of lateral branches, number of grains per square meter, 100-grain weight, grain yield, biological yield, and harvest index of cowpea (Mojaddam and Nouri, 2014). Tuarira and Moses (2014) found an increase in plant height of snap bean plants and seed yield as the population density is increased to 222,222 plants/ha, while the lower plant population of 125,000 plants/ha had the highest number of branches/plant, seeds/pod, number of pods/plant and high percent of good harvested seeds than other plant population densities. In common bean, recommended seeding density can depend on the growth habit of the plant, the yield–density relationship, percent emergence, seed cost and environment (Shirtliffe and Johnston, 2002). This reflects the differences between cultivars in yield-density relationship and seed cost.

Foliar spray can be of great effective because within short time the plant can transport nutrition from its leaves all the way down to its roots. Some seaweed extracts can be used as foliar spray and it is registered as a biostimulants. It elicits many beneficial responses including improved root and shoot growth, higher yields and greater resistance to abiotic and biotic stresses. Previously, cytokinins, auxins and polyamines were identified in the extract. Recently, other groups of plant growth regulators, abscisic acid, gibberellins and brassinosteroids have been quantified (Stirk et al., 2014). The beneficial effect of seaweed extract spraying on bean was demonstrated in terms of increase in growth characteristics i.e., number of leaves/plant as well as leaves dry weight/plant and seed yield i.e., number and weight of seeds and number of pods compared with the control (Abou El-Yazied et al., 2012 and Kocira et al., 2013).

Based on the previous information the aim of this article was to aid the growers within simple practices for maximizing yield potential of snap bean crop. So we investigated the impact of sizing seeds before cultivation and utilizing the stimulation effect of foliar application of algae extracts for more vigorous plant growth impacted in yielding either green pods or quality of seeds. Regarding the relation between seed size and its cultivation rate, we cultivated the three sizes of seeds in two rates to clarify the optimum plant population per area unit under each seed size. So, this study was conducted with the objectives of determining appropriate sizing of the sowing seed, optimum plant density, algae extract foliar spray and their combination for better growth and seed yield attributes of common beans.

Materials and methods

Two field experiments were conducted during summer seasons of 2013 and 2014 at the experimental farm of vegetables at Kaha, Qalyubia Governorate, Horticulture Research Institute (HRI), Agriculture Research Center (ARC), Egypt. A lot of pure snap bean seed (*Phaseolus vulgaris* L.) cultivar Valantino was obtained from the Vegetable Crops Seed Production and Technology Department, HRI, ARC, Egypt. Sowing date of the experiment were done on 3rd and 4th of March in the two summer seasons 2013 and 2014, respectively. Seeds were sown in a single row on one side of the irrigation line. Each row was 4 m long and 0.6 m width. Each plot contained 3 rows. So the area of each plot was 7.2 m^2.

The experiment included three factors during the two growing seasons as follows:

1. **Seed size**, three different seed sizes were classified as follows:
   a. Large seeds obtained through sieve >4.76 mm diameter and the weight of 100 seeds was 25 g approximately.
   b. Small seeds obtained through sieve >4.0 mm diameter and the weight of 100 seeds was 18 g approximately.
   c. Control, seeds without grading and the weight of 100 seeds was 22 g approximately.

2. **Plant density**, included two treatments as follows:
   a. 33 plants/m^2, one plant/hill at 5 cm a part.
   b. 22 plants/m^2, one plant/hill at 7.5 cm a part.

3. **Foliar spray with algae extracts**

Foliar spray with algae extracts was carried out three times during plant growth period. The first time was applied after 21 days from seed sowing date and then two times each was applied after two weeks interval. The source of seaweed extract was from Misr-ElSalam International Company and the fresh water algae extract was from Algal Biotechnology Unit, National Research Centre, Egypt.

The types of algae extract which applied were as follows:

a. Seaweeds algae extract (Algost 3 ml/l) as recommended.