INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

IJPAES

Volume-4, Issue-3, July-Sept-2014

ISSN 2231-4490

Coden : IJPAES www.ijpaes.com

Received: 10th May-2014 *Revised: 26th May-2014* *Accepted: 27th May-2014*

Research article

DEVELOPMENT OF MUNG-BEAN SEED VIGOUR UNDER DIFFERENT IRRIGATIONS AND PLANT DENSITIES

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ABSTRACT: Production and cultivation of vigorous seeds are essential for improving stand establishment and crop yield under different environmental conditions. Thus, a field experiment was carried out as split plot based on RCB design with three replications in 2013 to determine the best developmental stage of mung-bean seeds under different water supply (I_1, I_2, I_3, I_4 for irrigation after 70, 100, 130 and 160 mm evaporation from class A pan, respectively) and plant densities (D_1, D_2 and $D_3$for 30, 50 and 70 plants/m^2, respectively). Seeds were harvested at five day intervals in eight stages. Mass maturity (end of seed filling phase) under I_1 for all densities was achieved at 1300 GDD, but under I_2, I_3 and I_4 it was occurred at 1200 GDD for30 plant/m^2 and at about 1100 GDD for 50 and 70 plant/m^2. Maximum seed vigour as measured by germination rate, electrical conductivity of seed leachates and seedling dry weight was obtained at about mass maturity or 100 - 200 GDD after this stage, depending on densities and irrigation treatments. Seed moisture content at this stage was about 20%. Therefore, it was concluded that high vigour seeds of mung-bean can be produced under various environments, provided the seeds are harvested at about 20% moisture content.
Key words: Mass maturity, Mung- bean, Plant density, Seed vigour, Water supply

INTRODUCTION

The mung-bean is widely grown in Southeast Asia, Africa, South America and Australia. It was apparently grown in the United States as early as 1835 as the Chickasaw pea. In many regions where food legumes are grown, the climate is characterized by extremely variable and often chronically deficient rainfall. In such environments both agricultural scientists and farmers seek to identify crop and soil management techniques which make the maximum use of this scarce resource [1]. Farmers are interested to buy and cultivate vigourous seeds. Thus, production of high quality seeds is an important strategy for seed producers. High quality seed lots may improve crop yield in two ways: first because seedling emergence from the seedbed is rapid and uniform, leading to the production of vigourous plants, and second because percentage seedling emergence is high, so optimum plant population density could be achieved under a wide range of environmental conditions [2]. Maximum seed quality on the mother plant is attained at the end of seed filling period [3, 4, 5] or slightly after this phase [6, 7, 8]. Seeds can then retain their high quality for some time and thereafter begin to deteriorate on the mother plant or during storage, loosing viability and vigour [6, 9] In many agricultural areas of west Asia water resources are limited and production of high quality seeds in this region is very important. Ghassemi-Golezani et al. (1997) found that severe water deficit (irrigation after 180 mm evaporation from class A pan) reduced seed yield of maize and sorghum by 44% and 27%, respectively. However, there was no significant effect of water stress on seed vigour [10]. Similar results were reported for soybean [11] and common bean [8]. In contrast, some other studies showed that water deficit during grain filling significantly reduced seed quality of dill [12] and soybean [13]. According to Ghassemi-Golezani et al. (2012) mean seed weight of pinto bean cultivars significantly decreased as the plant density increased [14]. However, seed vigour as measured by germination rate and seedling dry weight was not significantly affected by plant density. Similar result was reported for chickpea cultivars [15]. No effect of plant density on seed quality had a practical value for commercial seed producers, but was not of relevance to the elucidation of those factors responsible for seed quality. Thus, the objective of this research is to determine the best developmental stage of mung-bean seeds at which maximum quality could be achieved at different plant densities and irrigation treatments.

MATERIAL AND METHODS

A split plot experiment (using RCB design) with 3 replications was conducted in 2013 at the Research Farm of the Faculty of Agriculture, University of Tabriz, Iran (Latitude38°05' N, Longitude 46°17' E, altitude 1360 m above sea level). The climate is characterized by mean annual precipitation of 245.75 mm per year and mean annual temperature of 10°C.

Irrigation treatments (I_1, I_2, I_3 and I_4: irrigation after 70, 100, 130, 160 mm evaporation from class A pan, respectively) were assigned to main plots and densities (D_1=30, D_2=50 and D_3=70 plants/ m^2) were allocated to sub plots. Seeds of mung-bean was treated with 2g/kg Benomyl and then were sown by hand in 4 cm depth of the sandy loam soil. Each plot consisted of 6 rows of 3.5 length; spaced 25cm apart. All plots were irrigated immediately after sowing, but after seedling establishment, irrigations were carried out according to the treatments. Hand weeding of the experimental area was done as required. After seed formation, 10 plants from each plot were harvested at five day intervals in eight stages. Then seeds were detached from the pods and seed moisture content was determined in accordance with ISTA rules (2010) [16]. Subsequently, seeds were ambient air dried and 1000 seed weight of each sample was determined. Seed samples within separate sealed bags were then placed in a refrigerator at 3-5°C. Seed vigour tests were carried out at the Seed Technology Laboratory of the University of Tabriz. Four replicates of 50 seeds from each sample were weighed (SW1 and SW2) and then seeds of each replicate immersed in 250 ml distilled water in a container at 20 °C for 24 hours. The seed-steep water was then gently decanted and EC was measured, using an EC meter (EC1 and EC2). Following equation was applied to calculate conductivity per gram of seed weight for each sample [17].

$$EC\ (\mu s/cm/g) = [(EC1/SW1) + (EC2/SW2)]/4$$

Four replicates of 10 seeds from each sample were tested for germination between double layered rolled filter papers. The rolled papers with seeds were put into the plastic bags to avoid moisture loss Seeds were allowed to germinate at 20±1°C for 7 days. At the end of each test, [16] germination rate was calculated. Normal seedlings were then dried in an oven at 80 °C for 24 hours [18] and mean seedling dry weight (SDW) for each treatment at each replicate was determined.

The accumulated growth degree-days (GDD) were computed from flowering time by a base temperature (Tb) of 12°C.

$$GDD= \Sigma\ (T\ max+ T\ min) / 2 - Tb)$$

Where T max and T min are maximum and minimum air temperatures, respectively. Excel software was used to draw figures.

RESULTS AND DISCUSSION

Seed weight of mung-bean under different irrigation treatments increased with increasing GDD, up to mass maturity (end of seed filling). Thereafter, no considerable changes in seed weight was observed. Maximum seed weight under I_1 for all densities was achieved at 1300 GDD, but under I_2, I_3 and I_4 it was obtained at 1200 GDD for30 plant/m^2 and at about 1100 GDD for 50 and 70 plant/m^2. Maximum seed weight under limited irrigation conditions was lower than that of under well watering and decreased with increasing plant population density (Figure 1).

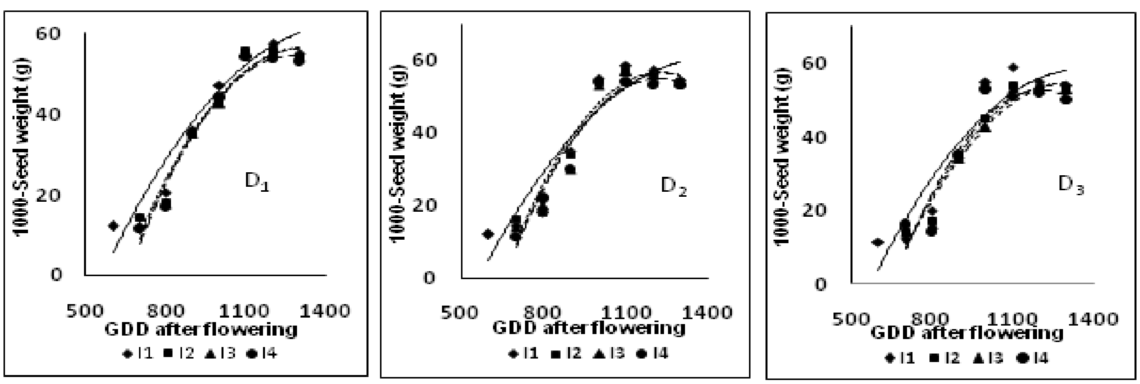

Figure 1. Changes in seeds weight of three densities of mung-bean at different stages of maturity under different irrigation treatments. I_1, I_2, I_3 and I_4: irrigation after 70, 100, 130 and 160 mm evaporation from class A pan, respectively. GDD: growing degree days.

Water stress reduces photosynthetic production because of stomatal closure and early senescence which ultimately affect seed development processes [19]. Seed filling duration of mung-bean seeds under well-irrigated treatment was higher than that of under limited irrigations, leading to the production of comparatively larger seeds. Decreasing seed weight with increasing plant densities (Figure-1) could be attributed to the increasing competition for water and other resources among plants [14]. Electrical conductivity (EC) of leachates for mung-bean seeds at early stages of seed development under all irrigation treatments was very high, but decreased with improving seed development. Minimum electrical conductivity for 30 and 50 plants/m^2 under all irrigation treatments and for 70 plants/m^2 under I_1 was achieved at about 1300 GDD and for 70 plants/m^2 under I_2,I_3 and I_4 was occurred at about 1200 GDD after flowering (Figure 2). High electrical conductivity values of seed lots at the early harvests were due to immaturity, which had placed them as low vigour seed lots [20, 21, 9].

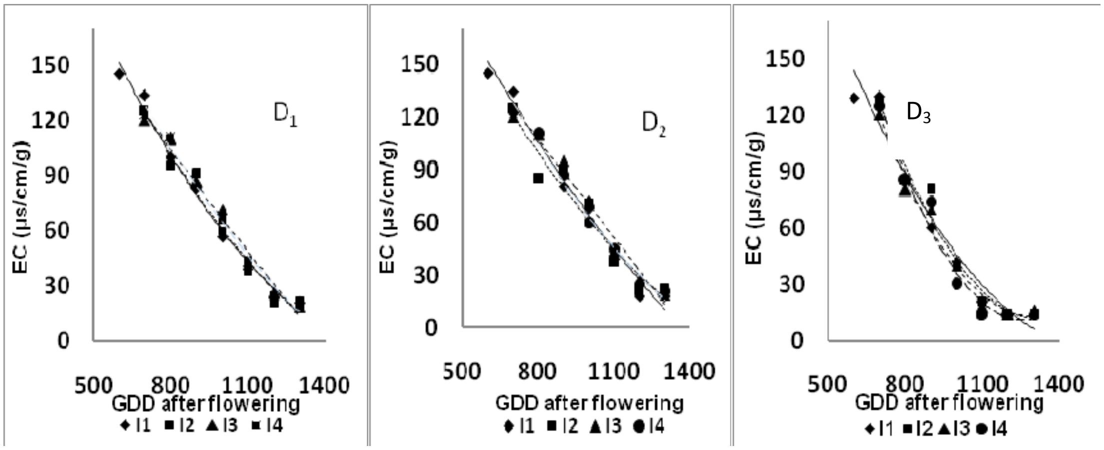

Figure 2. Changes in electrical conductivity (EC) of three mung-bean seeds at different stages of maturity under different irrigation treatments.

Germination rate of mung-bean increased with increasing GDD after flowering. Maximum germination rate for all densities and irrigation treatments were recorded at about 1300 GDD after flowering (Figure-3).

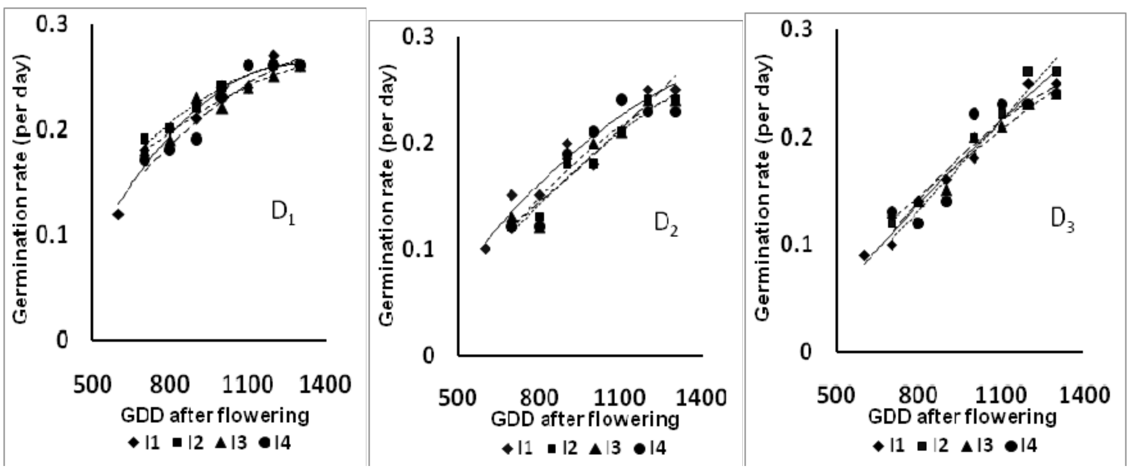

Figure 3. Changes in rate of germination of three mung-bean densities at different stages of maturity under different irrigation treatments.

Dry weight of seedlings from seeds produced at different densities increased with seed development up to about 1300 GDD under well watering (I_1) and 1200 GDD under limited irrigations (I_2,I_3 and I_4). In general seeds produced under I_1 had the largest seedlings (Figure 4). The maximum possible vigour is determined by genotype, but it may be modified by the environment during maturation on the mother plant such as plant densities [22, 14].

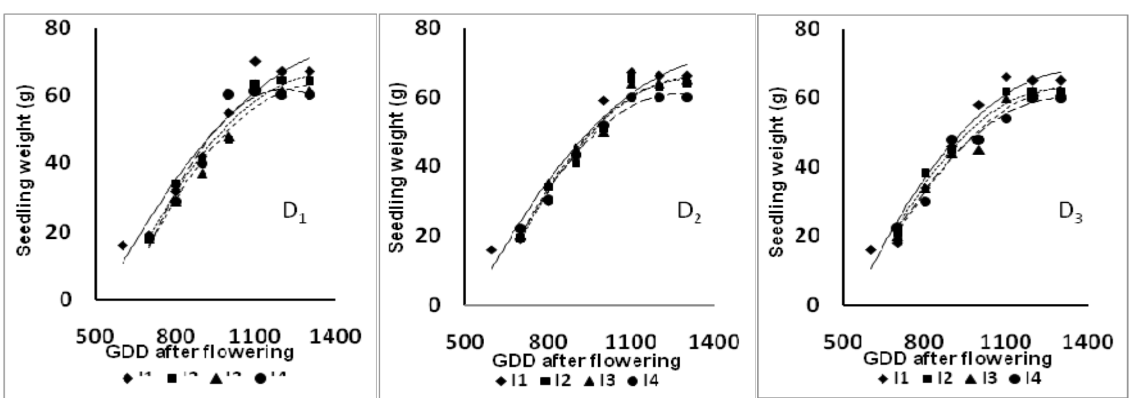

Figure 4. Changes in Seedling weight of three mung-bean densities at different stages of maturity under different irrigation treatments.

Maximum seed vigour as measured by germination rate, minimum electrical conductivity and maximum seedling weight was obtained at about mass maturity or 100 - 200 GDD after this stage, depending on densities and irrigation treatments (Figures 1-4). Seed moisture content at this stage was about 20%. Therefore, high vigour seeds of mung-bean can be produced under different irrigation treatments and plant densities provided the seeds are harvested at about 20% moisture content.

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