Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Annals of Biological Research, 2013, 4 (2):292-296
(http://scholarsresearchlibrary.com/archive.html)

ISSN 0976-1233
CODEN (USA): ABRNBW

Effect of seed priming on red bean (*Phaseolus calcaratus*) growth and yield

Setareh Rastin[1], Hamid Madani[2] and Shahram Shoaei[3]

[1]Department of Seed Science and Technology, Ashtian Branch, Islamic Azad University, Ashtian, Iran
[2]Department of Agronomy, Arak Branch, Islamic Azad University, Arak, Iran
[3]Agricultural Department, Ashtian Branch, Islamic Azad University, Ashtian, Iran

---

ABSTRACT

Planting high quality seeds with high germination percentage is important in agriculture, especially in mechanized and industrialized systems. So, this experiment was conducted in 2011 in Arak, Iran, to evaluate the effect of seed priming treatments on the seed quality of red bean. The experiment was conducted in split plot in the form of a randomized complete block design with three replications and two factors. The first factor was primary seed priming, in which seeds were or were not treated with water, for 14 hours. The second factor was complementary seed priming which was conducted after drying the seeds treated in the first step. In this step, water, 100 ppm KCl, 0.5% $CaCl_2.2H_2O$, 50 ppm KH_2PO_4 and 20 ppm GA_3 were used to treat seeds for 14 hours. Results indicated that the primary seed priming had no significant effect on none of the measured traits. However, complementary seed priming significantly affected plant dry matter, grain yield, 100 grain weight and the number of pods. The interaction of two factors had only a significant effect on 100 grain weight. Mean comparison indicated that the highest plant dry matter (53.06 g) and the highest grain yield (5.98 t/ha) were both achieved when seeds were first treated with water (as the primary seed priming) and after drying were treated with GA_3 (as the complementary seed priming). On the other hand, the lowest plant dry matter (23.30 g) and the lowest grain yield (3.17 t/ha) were also observed when seeds were first treated with water and after drying, were treated again with water.

Keywords: $CaCl_2.2H_2O$, GA_3, KCl, KH_2PO_4, *Phaseolus calcaratus*,

---

INTRODUCTION

Providing enough food with high quality for the increasing population is the most challenging issue for researchers and governments. Protein content is an important feature of a healthy food. Protein can be obtained from two sources: animal meat and some plants. Cereals and legumes are the main plants eaten by human. Cereals are the source of calories and carbohydrates, and legumes provide proteins to human body. Legumes contain on average 25% proteins, which makes them a valuable food [1, 13].

Beans are the most important legumes widely cultivated all over the world. Statistics shows that bean grain yield has increased from 7 million ton in 1945 to 19 million ton in 2004. Asian and American countries are the most important bean producers which produce about 87% of world production [19].

Seed priming is one of the methods of increasing yield in different crops including beans. This priming may be conducted by using water or some chemical substances; increasing seed quality and germination. High germination percentage and simultaneous germination are two desired traits in mechanized agriculture [16, 21]. Complementary seed priming is a water balance dependent process which is conducted by soaking seeds in water for a certain time to accelerate their germination. The complementary seed priming stimulates many metabolic processes related to seed germination [3, 9]. Veera Raj et al. [23] soaked the seeds of six rice cultivar in water for 24 h and then dried them for 48 h. Germination of soaked seeds varied from 41 to 100% in different cultivars during the first 24 h; however, it took 48-72 h for non treated seeds to germinate. On the other hand, soaking rice seeds in water increased all growth parameters of seeds such as the number and length of roots, root weight, shoot length and shoot yield. Nalawadi et al. [20] reported that soaking soybean seeds in water for 48 h had significant effect on germination rate and seedling weight. The treatment increased germination percentage from 21.20 to 54.0% and seedling weight from 1.73 to 3.44 g. Massawe et al. [6] also reported that soaking seeds of three groundnut cultivars in water increased germination percentage (from 49 to 74%), seedling emergence (from 42 to 72%) and seedling dry weight (from 160 to 250 g). On the other hand, results indicated that soaked seeds started to germinate after 4 days bun non-treated seeds started to germinate after 6 days. In field experiments, Joudi and Sharif [10] found that soaking barley seeds in water can improve seedling establishment in dry conditions.

In addition to water, some other chemical substances may also be used in seed priming. Higher germination percentage is observed in seeds treated with calcium salts; germination percentage and salts concentration were significantly correlated [5, 11]. Kathiresan et al. [8] reported that treating sunflower seeds with 20% KH_2PO_4 improved emergence and early growth of seedlings in field. Kulkarni and Eshanna [14] found that treating maize seeds with 1% calcium chloride increased germination percentage and speed, emergence and seed vigor index compare with the non-treated seeds. Ramalal et al. [12] showed that soaking maize seeds in KH_2PO_4 solution significantly increased germination percentage and speed, shoot length, root length and seedling weight. Qingxiang et al. [22] also reported that treating maize and soybean seeds with Kinetin and GA_3 increased seedling emergence and initial growth; GA_3 was more effective than Kinetin.

Regarding the benefits of seed priming with water or chemical substances, the objective of this experiment was to evaluate the effect of primary and complementary seed primings on the growth and yield of red bean (*Phaseolus calcaratus*).

MATERIALS AND METHODS

This experiment was conducted in 2011 in Ardeshir Rastin farm, Aman Abad, Arak, Iran, (49° 54' E, 34° 45' N and 2050 m above the sea level). Soil type at the test site was clay loam (clay, 33; Silt 23; sand 44%) with the pH of 7.7. Other physic-chemical properties of soil are listed in Table 1.

Table 1. Physic-chemical properties of the test site soil.

Depth (cm)	EC (ds/m)	P_{ava} (ppm)	K_{ava} (ppm)	N (ppm)	OC (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
0-30	2.2	8.9	195	0.08	0.83	4.8	0.78	4.4	0.4

The experiment was conducted in split plot in the form of a randomized complete block design with three replications and two factors:

Primary seed priming. This treatment was in two levels: seed were soaked (Q_1) and were not soaked (Q_2) in water for 14 h.

Complementary seed priming. This treatment was in six levels: seeds were not soaked (control, T_1), were soaked in water (T_2), 100 ppm KCl (T_3), 0.5% $CaCl_2.2H_2O$ (T_4), 50 ppm KH_2PO_4 (T_5) and 20 ppm GA_3 (T_6) for 14 h. For complementary seed priming of those seeds which had received primary seed priming, seeds were first dried for three days in open air.

The field was prepared in the conventional method. Animal manure was added 15 days before cultivation. 40 kg N/ha, 80 kg P2O5/ha and 25 kg K2O/ha was also added to field at cultivation. Treated seeds were cultivated in 10 × 30 cm intervals. Weeds were manually control at 20 and 30 days after planting. After harvest at the physiological maturity, samples were dried under sunshine and pounded to split the seeds from pods. Then, seeds were cleaned and stored under sunshine to reach the 8% humidity.

After measuring the required parameters, data were analyzed using SAS and MSTAT-C and means were compared according to the Duncan's multiple range test. Graphs were also created using Microsoft Office Excel.

RESULTS

Plant dry matter. Results indicated that the primary seed priming (Q) and the interaction of primary seed priming × complementary seed priming (T) had no significant effect on plant dry matter; however, the effect of complementary seed priming was significant (Table 2). Mean comparison indicated that the highest plant dry weight (53.06 g) was achieved in Q_1T_3, in which seed were treated first with water and then with GA_3, and the lowest plant dry weight (23.30 g) was achieved in Q_1T_6, in which seeds were treated first with water and then again with water (Table 3).

Table 2. Analysis of variance of the effect of treatments on the measured traits

SOV	df	Mean Squares (MS)						
		Plant dry matter	Grain Yield	100 grain weight	Root Length (15 DAP)	Number of pods	Number of grains in a pod	Harvest Index
Block	2	ns	ns	ns	ns	ns	ns	ns
Q	1	ns	ns	ns	ns	ns	ns	ns
Error	2	67.05	4.42	0.07	1.25	33.65	0.20	0.010
T	5	**	*	**	ns	**	ns	ns
Q × T	10	ns	ns	*	ns	ns	ns	ns
Error	20	43.85	1.21	0.46	2.72	19.15	0.29	0.002
CV (%)	-	21.64	27.34	2.48	22.69	25.53	15.60	9.56

*ns, nonsignificant; **, significant at P≤0.01; *, significant at P≤0.05.*
Q, primary seed priming (soaking seeds in water).
T, complementary seed priming (soaking seeds in water, 100 ppm KCl, 0.5% $CaCl_2.2H_2O$, 50 ppm KH_2PO_4 and 20 ppm GA_3).
DAP, days after planting.

Table 3. Effect of treatments on the measured traits

Treatments	Plant dry matter (g)	Grain Yield (t/ha)	100 grain weight (g)	Root Length 15 DAP (cm)	Number of pods	Number of grains in a pod	Harvest Index
Q_1	32.48a	4.19a	27.56a	6.87a	17.45a	3.41a	0.51a
Q_2	28.68	3.86a	27.60a	7.68a	16.81a	3.57a	0.53a
T_1	28.90b	4.10b	28.16a	7.01a	16.31b	3.51a	0.56a
T_2	27.43b	3.58b	28.21a	8.19a	14.78b	3.45a	0.51ab
T_3	45.86a	5.53a	27.43ab	6.79a	23.90a	3.26a	0.47b
T_4	25.88b	3.43b	28.01a	6.72a	14.23b	3.70a	0.51ab
T_5	31.06b	4.29ab	26.78b	7.83a	19.36ab	3.73a	0.54a
T_6	24.38b	3.23b	26.86b	8.19a	14.21b	3.26a	0.51ab
Q_1T_1	33.06bc	4.57ab	29.06a	7.04a	17.13abcd	3.63ab	0.55ab
Q_1T_2	26.93bc	3.23b	28.1ab	7.77a	13.96cd	3.33ab	0.46bc
Q_1T_3	53.06a	5.98a	27.43bc	6.42a	25.00a	3.33ab	0.43c
Q_1T_4	26.50bc	3.58b	28.00ab	6.12a	16.60bcd	3.00b	0.52abc
Q_1T_5	32.06bc	4.62ab	26.46c	6.45a	17.66abcd	3.90ab	0.56a
Q_1T_6	23.30c	3.17b	26.30c	7.40a	14.36bcd	3.26b	0.52abc
Q_2T_1	24.73c	3.63b	27.26bc	6.98a	15.50bcd	3.40ab	0.58a
Q_2T_2	27.93bc	3.92ab	28.33ab	8.60a	15.60bcd	3.56ab	0.56ab
Q_2T_3	38.66b	5.09ab	27.43bc	7.15a	22.80ab	3.20b	0.52abc
Q_2T_4	25.26c	3.27b	28.03ab	7.32a	11.86d	4.40a	0.5abc
Q_2T_5	30.06bc	3.97ab	27.10bc	9.21a	21.06abc	3.56ab	052abc
Q_2T_6	25.46c	3.30b	27.43bc	6.80a	14.06cd	3.33ab	0.51abc

Means in a column followed by the same letter are not significantly different at P≤0.05.
Q1, seeds were soaked in water; Q2, seeds were not soaked in water.
T_1, seeds were not treated (control); T_2, seeds were soaked in 100 ppm KCl; T_3, soaked in 20 ppm GA_3; T_4, soaked in 0.5% $CaCl_2.2H_2O$; T_5, soaked in 50 ppm KH_2PO_4; T_6, soaked in water.
DAP, days after planting.

Grain yield. Analysis of variance showed the significant effect of complementary seed priming on grain yield; the effect of primary seed priming and the interaction of two factors were not significant. Mean comparison also showed that the highest grain yield (5.98 t/ha) was achieved in Q_1T_3, in which seed were treated first with water and then with GA_3, and the lowest grain yield (3.17 t/ha) was achieved in Q_1T_6, in which seeds were treated first with water and then again with water (Table 3).

100 grains weight. Results of this experiment indicated that 100 grains weight was not significantly affected by the primary seed priming; however, complementary seed priming and the interaction of primary seed priming × complementary seed priming had significant effect on this trait (Table 2). In mean comparison it was revealed that the highest 100 grains weight (29.06 g) was achieved in Q_1T_1, in which seeds received only a primary seed priming (only water). On the other hand, the lowest 100 grains weight (26.30 g) was achieved in Q_1T_6, in which seeds were treated by water at primary stage and again by water at complementary stage.

Root length 15 days after planting. Analysis of variance represented that root length 15 days after planting was not significantly by any factor of the experiment, including primary seed priming, complementary seed priming or their interaction (Table 2). According to the Duncan's mean comparison, although the highest root length (9.21 cm) was achieved in Q_2T_5, in which seeds did not receive any primary treatment and after that received KH_2PO_4 treatment at the complementary priming; however, all treatment were in a statistically same group (Table 3).

Number of pods. Results indicated that the primary seed priming had no significant effect on the number of pods. Complementary seed priming significantly affected this trait at $P \leq 0.01$. Interaction of the two factors had also no significant effect on the number of pods (Table 2). Mean comparison represented that the number of pods was the highest (25.00) in Q_1T_3, in which seeds were first treated with water and then with GA_3. On the other hand, the lowest number of pods (11.86) was achieved Q_2T_4, in which seeds received no primary seed priming and after that were treated with $CaCl_2.2H_2O$ (Table 3).

Number of grains in a pod. Analysis of variance indicated that none of the treatments of this experiment had significant effect on the number of grains in a pod. Effect of interaction of the two factors was also non-significant (Table 2). Mean comparison showed that the highest number of grains in a pod (4.40) was achieved in Q_2T_4, in which seeds did not receive any primary treatment and only received $CaCl_2.2H_2O$ as the complementary seed priming. The lowest number of grains in a pod (3.00) was also achieved in Q_1T_4, in which seeds were treated first with water and then with $CaCl_2.2H_2O$ (Table 3).

Harvest index. Studying the analysis of variance represented that primary seed priming and complementary seed priming had no significant effect on the harvest index. On the other hand, interaction of the two factors had also no significant effect on this trait (Table 2). Mean comparison indicated that the highest harvest index (0.58) was related to Q_2T_1, in which the seeds received neither primary seed priming nor complementary seed priming. Moreover, the lowest harvest index (0.43) was related to Q_1T_3, in which seeds were treated with water as the primary seed priming and GA_3 as the complementary seed priming (Table 3).

DISCUSSION

Results indicated that seed priming, mainly complementary seed priming with chemical substances significantly increased the measured factors including plant dry matter, grain yield, 100 grain weight, root length, the number of pods and the number of grains in a pod.

These results are observed in other experiments. Desai et al. [3] found that complementary seed priming affects many metabolic processes involved in germination and initial growth of plants; because priming stimulates some physiological activities in seed before planting, they will germinate faster when planted. Nalawadi et al. [20] found that soaking soybean seeds in water for 24 hours has significant effect on germination and seedling fresh weight; increasing germination percentage from 21.20 to 54% and seedling weight from 1.73 to 3.44 g. Khan et al. [7] reported that soaking the seeds of sunflower in water for 24 h and then drying it back to the original humidity percentage significantly increased germination percentage, emergence for field soil, root length, shoot length and seed vigor index. Basu and Choudhary [17] reported that treating soybean seeds with water before planting significantly increased field emergence (from 61.90 to 97.77%), germination speed (from 29.27 to 32.59) and seedling weight (from 3.73 to 3.92 g). Joudi and Sharif [10] also reported that seed priming techniques increase seed quality, germination percentage and seedling establishment rate under harsh environmental conditions.

Punjabi et al. [2] showed that treating barley seeds with water for 2 h and then drying them increased grain yield from 2.11 to 2.47 t/ha. Chatterjee et al. [4] also represented that groundnut yield was improved by 30-50% when seeds treated with water were planted. In their experiments, priming seeds with water increased pod yield (from 899 to 1476 kg/ha), the number of pods (from 8.80 to 9.80) and 100 grain weight (from 172.80 to 192.30 g).

In addition to water, some chemical substances may also be used in seed priming; their effect is studied in different experiments. Christiansen and Foy [11] found higher germination percentage when seeds were primed with calcium salts. Ghosh and Sen [18] found that treating Ber (*Ziziphus mauritiana* Lank) seeds with 1% potassium dihydrogen phosphate increased germination percentage. Subbaraman and Slevaraj [15] also reported that treating groundnut seeds with 0.5% $CaCl_2$ solution for 32 h and then drying them for 10 h increased germination percentage (from 77 to 98%), field emergence (60.91 to 92%), seed vigor (from 3007 to 3372) and oil content (from 50.72 to 47.19%).

CONCLUSION

Results of this experiment generally indicated the significant effect of seed priming on red bean growth and yield. According to the results, the most effective seed priming technique was the one in which seeds were first treated with water as the primary seed priming and after drying were treated with GA_3. This treatment increased grain yield by 64.74% and plant dray matter by 114.56% compared with the non-treated seeds. The least effective treatment was the one in which seeds were first treated with water and after drying were again treated with water; this treatment even reduce grain yield and plant dry matter compared with the non-treated seeds.

REFERENCES

[1] A Koochaki and M Banayan Aval, Legumes Cultivation, Mashhad Jahad Daneshgahi Publications, Iran, **2002**.
[2] B Punjabi, AK Mandal and RN Basu, *Seed Research*, **1982**, 10 (1), 69-71.
[3] BB Desai, PM Kotecha and DK Salunkhe, Seeds Handbook. Marcel Dekker, Inc., New York, **1997**.
[4] BN Chatterjee, RK Ghosh and B Dasgupta, *J Oilseeds Res*, **1982,** 2, 246-254.
[5] C Hecht-Buchholz, *Soil Sci Plant Anal*, **1979,** 10, 67-81.
[6] FJ Massawe, ST Collisions, JA Roberts and SN Azam-Ali, *Seed Sci Technol*, **1999**, 27, 893-905.
[7] GM Khan, K Keshavulu, BM Reddy and K Radhika, *Seed Res*, **2003**, 31 (1), 94-97.
[8] K Kathiresan, V Kalyani and JL Gnanarethinam, *Field Crop Res*, **1984,** 9 (3/4), 215-217.
[9] LO Copeland and MB Mcdonald, Principles of Seed Science and Technology, 3rd ed., Chapman and Hill, New York, **1995**.
[10] M Joudi and ZF Sharif, *Scientific Information Database*, **2006**, 13, 11.
[11] MN Christiansen and CD Foy, *Soil Sci Plant Anal*, **1979**, 10, 427-442.
[12] MU Ramalal, SD Shashidhara and BS Vyakaranahal, *Mysore J of Agric Sci*, **1993**, 27, 16-23.
[13] N Majnun Hoseini, Legumes Cultivation, Jahad Daneshgahi Publications, Iran. **1996**.
[14] NG Kulkarni and MR Eshanna, *Seed Res*, **1988**, 16(1): 37-40.
[15] R Subbaraman and JA Slevaraj, *Seeds and Farms*, **1989**, 4, 5-9.
[16] RN Basu, Proceedings of the International Conference on Seed Science and Technology, New Delhi, India**, 1990**.
[17] RN Basu and P Choudhary, *Annals Agric Res*, **2005,** 11, 285-288.
[18] SN Ghosh and SK Sen, *South Indian Hort*, **1988**, 36, 260-261.
[19] T Rahnamaei, MSc Thesis, Islamic Azad University, Karaj branch, Iran. **2005**.
[20] UG Nalawadi, S Prithviraj and K Krishnmurthy, *Indian J Agric Sci*, **1973**, 43, 546-550.
[21] W Heydecker, J Higgins and RL Gulliver, *Nature*, **1973**, 246, 42-44.
[22] W Qingxiang, Z Feng and LS Donald, *Environl Exptl Botany*, **1996**, 36 (4), 377-383.
[23] YS Veera Raj, KM Appaiah and KSK Shastry, *Mysore J Agric Sci*, **1970**, 4, 183-187.