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Full Length Research Paper

Effect of different hydropriming times on the quantitative and qualitative characteristics of chickpea (*Cicer arietinum* L.)

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In dry land areas of the western half of Iran, chickpea due to exposure to rotation with wheat and barley play an important role in maintaining survival of agriculture in these regions. Seed priming is a simple and cheap method and is highly efficient and acceptable, especially in areas with low fertility. In this study, effects of different times of hydropriming on yield, yield components, phenological characteristics and percentage of protein of chickpea (*Cicer arietinum* L.) were examined in a randomized complete block design with three replicates in 2010. Seeds of chickpea were exposed at six different hydropriming times (2 h, 4 h, 6 h, 8 h, 10 h and control). The results of this experiment showed that the effect of hydropriming treatments for main branch and lateral branch number, number of pod per plant, biological yield, grain yield, time from planting to emergence, emergence to flowering, flowering to bloom and pod forming and growth length was significant. However, there was no significant difference between treatments in terms of plant height, number of seed per pod, number of empty pod, seed thousand weight, harvesting index, pod forming to seed pods and blooming to maturity, and percentage of seed protein.

Key words: Chickpea, yield, phenological characteristics, hydropriming.

INTRODUCTION

In dry land areas, more seed planting depth may be considered due to soil moisture limitations, and in such circumstances, growth of seedlings may be difficult in that the seedlings are not well settled; however, if seeds germinate faster, they can be established properly (Artola et al., 2003). Importance of germination and early establishment in various plants is different; nonetheless, if the plant does not have tillering ability, due to the lack of appropriate green surface, the farm is not able to compensate for its photosynthesis level; thus, the importance of sprouting in these cases would be more (Savage et al., 2004). Hydropriming can be used to improve the germination and seedling establishment in low humidity conditions and low temperatures (Demir and Van De Venter, 1999). Seed priming techniques include treatments that have an influence on metabolic, bio-chemical and enzymatic status of seed, thereby raising its power in order to better play their biological functions, such as germination and seedling establishment (Farooq et al., 2006). Seed priming method is simple and inexpensive, and it does not need special technical complexity (Penalosa and Eira, 1993). Also, high performance and acceptability of it, especially in areas with low fertility where mainly poor farmers are living, made some of the researchers to say that it is a way to improve livelihoods of poor farmers and to reduce hungry problems (Demir and Oztokat, 2003; Demir and Van De Venter, 1999; Frett and Pill, 1991). In hydropriming method, seeds were treated with pure water without using any chemical, while the amount of water absorption

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was controlled by seeds through the period when seeds are in contact with pure water (Penalosa and Eira, 1993). With the decreasing duration of water absorption or performance of treatment in low temperature, rootlet is prevented (Fujikura et al., 1993). As a result of this treatment, the metabolic activity of germination is stimulated and it gains balance in a place that causes improvement of the germination rate, uniformity of plant growth and improvement in vigor and seedling growth (Artola et al., 2003; Fujikura et al., 1993). Acceleration of germination in prime seeds can be due to the increasing activity of the degrading enzymes, such as α- amylase, synthesis of RNA and DNA, the amount of ATP and the number of mitochondria (Afzal et al., 2002). In seedling, rootlet and stem length show increase in the germination of prime seeds, though this increase is higher in rootlet, growth rate and root development. Also, increase in cell divisions in the root cap is more and this along with better water and nutrient absorption can improve the establishment of plants. This matter in the study about the roots of tomato, maize and rice has been approved (Mauromicale et al., 1994). Rapid and optimal germination can often spread in the root system in a shorter time and it causes better establishment and usage of environmental inputs (Khan et al., 1992). For the fact that germination and seedling establishment in prime seeds is faster, better and more uniform, the plants develop their root system in a shorter time with favorable absorption of water and nutrients, and a production of the photosynthesis parts to reach the autotrophic period. However, having these conditions in terms of biological and ecological status is good for the plant (Duman, 2006). Seed priming give better utilization of the environmental inputs, such as: water, light to the plant, and ability to compete with other plants and organisms in terms of ecological characteristics. The results of these factors could lead to increase of the duration and level of photosynthesis in plants (Chivasa et al., 1998; Finerty et al., 1992). Clark et al. (2001) during a two-year experiment with corn observed that hydropriming can increase the yield of corn by an average of 14%. Kaur et al. (2005), during studies on the effects of seed priming on chickpea, observed that yield was increased by 11%. However, diverse results have been reported by other researchers; although, Bailly et al. (2000) reported that application of priming and osmopriming in sunflower reduced germination time. The purpose of this study was to determine the best time of hydropriming and its effects on various quantitative and qualitative characteristics of chickpea. Thus, the set of these traits can make growth of chickpea faster with better establishment of seedling in unfavorable dry land conditions and lead to better tolerance in this situation.

MATERIALS AND METHODS

This experiment was conducted in Mahidasht, Iran, with the geographic latitude of 34° 32' 53'' N and longitude of 46° 59' 16'' E and an elevation of 1371 m above sea level during the 2010 growing season. In this study, the seed of Hashem cultivar was prepared from the Sararood Dryland Institute, though the initial humidity of seeds was 10%. Seeds before planting were exposed to 6 hydropriming treatments (2 h, 4 h, 6 h, 8 h, 10 h and control) in a randomized complete block design with three replications. For doing hydropriming treatments, the required size of pea seeds in plastic containers were placed, and then distilled water was added to the seeds at a temperature of 25°C for 2, 4, 6, 8 and 10 h. Seeds after conducting priming treatments were air dried to reach the 10% humidity. The seeds were then put in the refrigerator at a temperature of 5°C until it was later used. Land preparation operations including ploughing, disk and trowel to the desired way, before planting was done in the first half of October. After taking track, map test was implemented on the ground. Planting chickpea as autumn planting in the first half of November was done by hand. Each plot contains 14 lines, and the distance between two lines in the plot was 50 cm, while the distance between two replicates was considered as two meters. Different stages of plant phenology were determined for 50% of the plants on that stage (Keatinge and Cooper, 1983); although, the seeds that part of their seedlings in the soil surface was visible as green seeds were considered (Fehr and Caviness, 1980). After removal of margins, plants were harvested by hand, while seed protein content was obtained through Kjeldahl method. The harvesting index was calculated by dividing grain yield (g)/on total shoot dry weight (g) (Keatinge and Cooper, 1983). Before complex statistical analysis, normality tests were performed and after ensuring normal distribution of data, their analysis was attempted. The data obtained from the study were analyzed by the statistical software of SAS, and the mean data were done by DUNCAN test ($P \leq 0.05$). Nonetheless, Excel 2003 software was used for charting.

RESULTS AND DISCUSSION

Plant height

The result of analysis of variance showed that hydropriming effect on plant height is not significant (Table 1).

Number of branches

Results of analysis of variance showed that the effect of hydropriming on number of main branch ($P \leq 0.05$) and the number of lateral branches was significant ($P \leq 0.01$) (Table 1). Hydropriming for 6 h and the control of plants had the highest (2.93) and lowest (2.57) number of main branches, respectively (Table 2); whereas the mean comparison showed that hydropriming for 6 h with 7.20 and hydropriming for 10 h with 5.43 had the maximum and minimum number of lateral branches respectively (Table 2). In 10 h hydropriming, the number of lateral branches reduced; in this case, determining the appropriate hydropriming time was obvious. Penalosa and Eiraw (1993) stated that the action of unsuitable hydropriming time has negative effects on tomato seeds. Increasing the number of main and lateral branches by hydropriming could probably be due to better performance of primed seeds in using environmental resources. It is possible that in plants that are established lately, reduction of soil moisture in the vegetative stage caused reduction in the number of branches. Also, it seems that in the treatments which have longer time of

Table 1. Analysis of variance of various quantitative and qualitative traits in response to various hydropriming times in chickpea plant.

Source of variation	Df.	Plant height	Number of main branches	Number of lateral branches	Number of pod/ plant	Number of seed/ pod	Number of empty pod	Seed thousand weight	Biological yield	Grain yield	Harvesting index
Block	2	2.58[ns]	0.123*	0.635[ns]	1.024ns	0.0024ns	0.802ns	379.0ns	163360.3ns	14635.9**	22.18ns
Hydropriming	5	2.21[ns]	0.097*	1.563**	11.112*	0.0045ns	0.223ns	62.6ns	255168.0*	6177.6*	8.77ns
Error	10	1.14	0.028	0.2237	3.315	0.0074	0.268	167.59	74830.5	1784.0	9.35
CV		3.2	6.3	7.5	9.5	7.8	10.0	4.2	9.1	5.5	11.8

*Significant at $P \leq 0.05$; **Significant at $P \leq 0.01$; df: degree of freedom; CV: coefficient of variation.

Table 2. Effect of different hydropriming times on plant height, and the number of main and lateral branches in chickpea.

Time (h)	Number of main branch	Number of lateral branch
0	2.57[b]	5.77[b]
2	2.57[b]	6.07[b]
4	2.90[a]	7.13[a]
6	2.93[a]	7.20[a]
8	2.63[ab]	6.20[a]
10	2.53[b]	5.43[b]

Each value is the mean of three replicates (Duncan's test, $P \leq 0.05$).

emergence, increasing temperature during vegetative growth caused the acceleration of the development and reduction of vegetative growth, which finally decreased the numbers of branches per plant.

Number of pods per plant

The results of this study showed that the effect of hydropriming on the number of pods per plant was significant ($P \leq 0.05$) (Table 1). Hydropriming for 6 h (22.2) and the control (16.8) had the highest and lowest number of pods per plant, respectively (Figure 1). Bastia et al. (1999) reported that the use of hydropriming treatment in safflower increased the number of heads per plant, the number of seeds per head, and the seed thousand weight and yield. Moreover, the cause of differences in the number of pods in plant could be due to the prolonged period of bloom and pod formation at the right time. Since it was found that hydropriming affected the phenological stages of growth, the role of the indeterminate chickpea growth in this case was not good; although flowering in the suitable environmental condition can produce the number of fertile flowers and consequently more pods. Nonetheless, Tomar et al. (1982) stated that lateral branches had an important role in the production of pods.

Number of seeds per pod

The analysis of variance showed that the effect of hydropriming on the number of seeds per pod was not significant (Table 1). In the study of other researchers, it was also observed that the number of seeds per pod was often in the control of genetic characteristics but less influenced by the agronomic and environmental factors (McKenzie et al., 1995; Mohammadi et al., 2005).

Empty pods

In this study, the result shows that the effect of hydropriming on empty pods per plant was not significant (Table 1).

Seed thousand weights

The analysis of variance showed that the effect of hydropriming on seed thousand weight was not significant (Table 1), though Mckenzie and Hill (1995) reported that the operation did not affect the seed thousand weight.

Biological yield

The effect of hydropriming on biological yield was significant ($P \leq 0.05$) (Table 1), in that hydropriming for 6 and 4 h with 3550.7 and 2776.5 kg/ha had the highest and lowest biological yield, respectively (Figure 2).

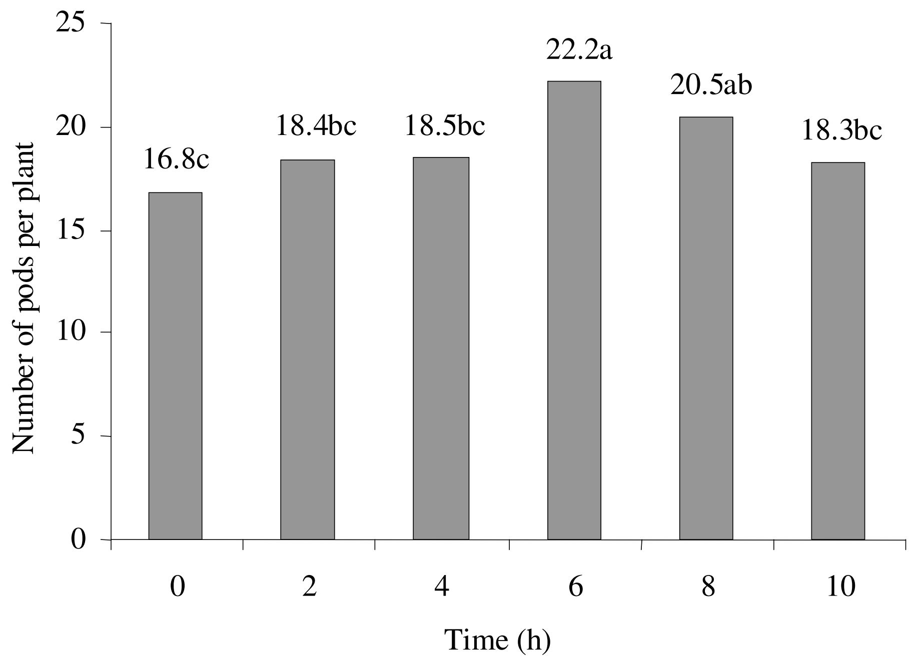

Figure 1. Effect of different hydropriming times on pods per plant in chickpea.

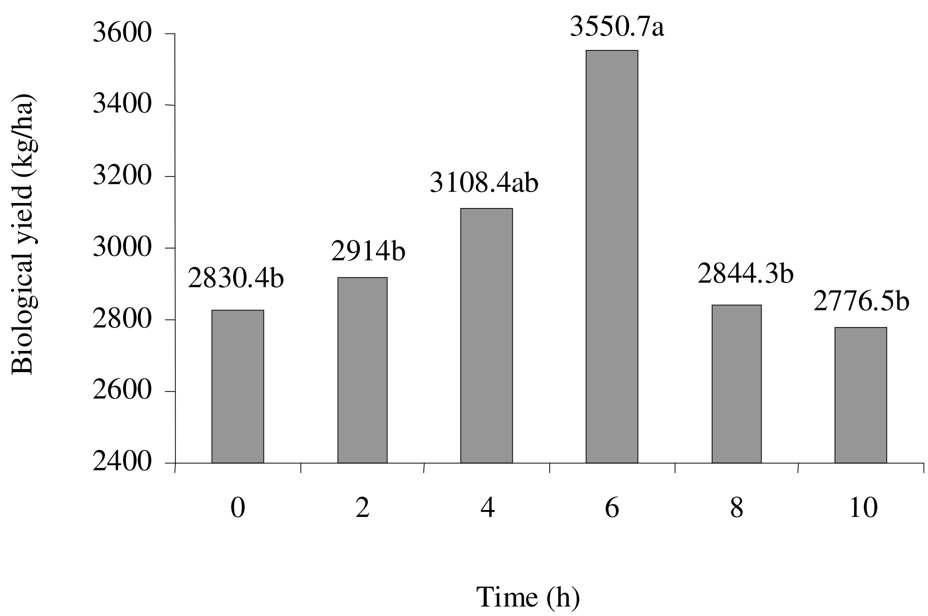

Figure 2. Effect of different hydropriming times on biological yield in chickpea.

Grain yield

The effect of hydropriming on grain yield was significant ($P \leq 0.05$) (Table 1). Hydropriming for 6 and 4 h with 859.9 and 732.5 kg/ha had the highest and lowest yield respectively (Figure 3). These results confirm those of Nagar et al. (1998), Clark et al. (2001), Kaur et al. (2005) and Harris et al. (2001). The difference between the treatments may be due to differences in the number of pods per plant from different hydropriming applied treatments. Also, the prolonged period of flowering to pod forming in suitable environmental condition can increase the number of pods per plant and thus grain yield. Earliness trait in dryland areas causes flowering and pod forming occurrence when thermal stress and less moisture is present. The research has shown that legu-

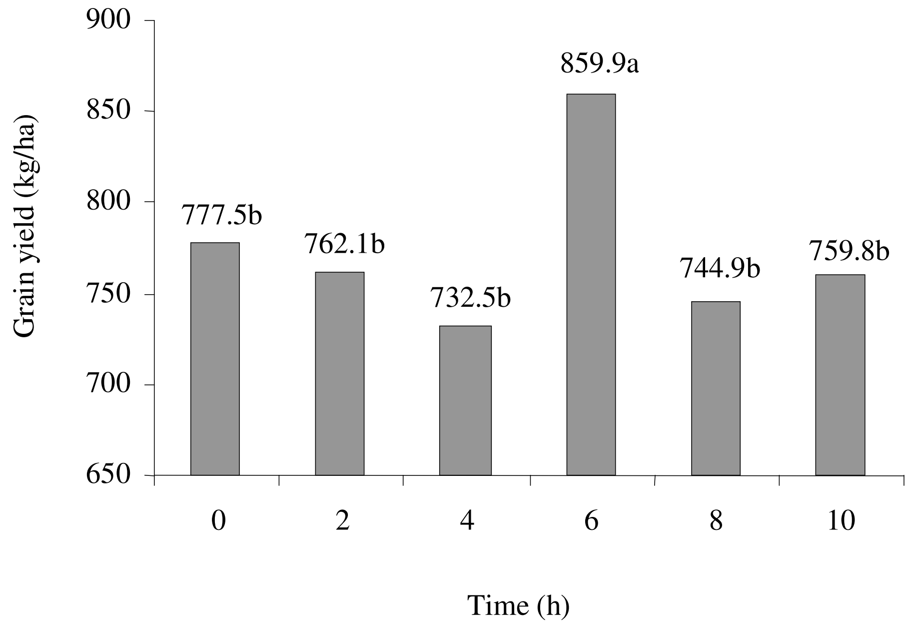

Figure 3. Effect of different hydropriming times on grain yield in chickpea.

mes yield fluctuations have a high dependence on weather condition at critical stages of growth, and dry and warm temperature caused reduction in plant growth (Saxena, 1990). Tomar et al. (1982) stated that the number of pods per plant is the highest part of chickpea yield.

Harvesting index

In this study, it was observed that hydropriming effect on harvesting index was not significant (Table 1).

Seed protein

In this study, the effect of hydropriming on percentage of seed protein was not significant (Table 3).

Phenological stages

The phenological stages of chickpea were affected by hydropriming treatments. The effect of hydropriming on planting to emergence time, emergence to flowering and overall growth period ($P \leq 0.01$) and time of flowering to pod forming was significant ($P \leq 0.05$), but the time of pods forming to maturity was not affected by hydro-priming treatments (Table 3). The control treatment and hydropriming for 6 h had the longest (16.3 days) and shortest (12.3 days) planting to emergence time, respectively (Table 4); thus, this result confirm those of Nagar et al. (1998), Bailly et al. (2000) and Farooq et al. (2010). Rapid germination and seedling establishment in prime seeds caused plants to reach autotrophy stage in shorter time and give good competitive ability to the plant (Demir and Van De venter, 1999). Since the planting to emergence time was affected by the hydropriming treatments, the emergence date as compared to the control was different. In fact, we can say that hydropriming in addition to the stated effects has the same effect on the planting date as well. Planting date affects the phenological stages of pea, in that in dry conditions, it usually relies on stored moisture in the cultivated soil, and is associated with the increasing temperature in the end of the growing season (Saxena, 1990); although, short interval from planting to emergence is important in such circumstances. Control treatment and hydropriming for 6 h had the longest and shortest time from emergence to flowering for 55.3 and 48.7 days respectively (Table 4). It seems that in early establishment, vegetative and reproductive growth was faced with proper temperature and humidity, so the ability of plant to produce dry matter and create larger the reservoirs would be increased (Saxena, 1980). A study of mean comparison (Table 4) shows that hydropriming of 6 h and control treatment had the longest and shortest period from flowering to pod forming time for 13.67 and 11 days, respectively. Progress of the developmental stages of chickpea is associated with the increasing temperature and day length. Also, evapotranspiration during reproductive growth increased and the plant faced with limited soil moisture caused the plant reproductive period to reduce. Control treatment and hydropriming for 6 h had the longest and shortest growth period (planting to maturity) for 102.7 and 95 days, respectively (Table 4).

Table 3. Analysis of variance of phenological stages and seed protein in response to various hydropriming times in chickpea plant.

Source of variation	Df.	Planting to emergence	Emergence to flowering	Flowering to pod forming	Pod forming to maturity	Maturity	Seed protein
Block	2	0.389^{ns}	26.0*	1.556^{ns}	0.056^{ns}	18.67*	0.329^{ns}
Hydropriming	5	7.389**	28.77**	3.289*	1.689^{ns}	32.67**	0.490^{ns}
Error	10	1.056	4.67	0.956	2.322	3.53	1.322
CV		7.1	3.8	8.0	7.7	1.9	4.5

*Significant at $P \leq 0.05$; **significant at $P \leq 0.01$; df: degree of freedom; CV: coefficient of variation.

Table 4. Effect of different hydropriming times on the time from planting to emergence, emergence to flowering, flowering to pod forming, pods forming to maturity and growth duration (per day) in chickpea.

Time (h)	Planting to emergence (day)	Emergence to flowering (day)	Flowering to pod forming (day)	Forming pods to maturity (day)	Growth duration (day)
0	16.3^{a}	55.3^{a}	11.0^{c}	20.0^{a}	102.7^{a}
2	15.3^{a}	53.3^{a}	11.7^{bc}	20.7^{a}	101.0^{ab}
4	14.7^{a}	52.7^{ab}	11.7^{bc}	19.3^{a}	98.3^{bc}
6	12.3^{b}	48.7^{c}	13.7^{a}	20.3^{a}	95.0^{c}
8	12.7^{b}	49.0^{bc}	13.3^{ab}	20.3^{a}	95.3^{c}
10	15.0^{a}	56.0^{a}	12.0^{abc}	18.7^{a}	101.7^{ab}

Each value is the mean of three replicates (Duncan's test, $P \leq 0.05$).

It seems that rapid germination and appropriate establishment of plant caused the plant to finish its vegetative and reproductive growth in a shorter time. It is possible that in the treatments which have longer emergence time, increasing temperature during vegetative period causes reduction of the vegetative growth which resulted in reduction of the crop growth period. Thus, changes in the phenological stages can affect plant growth and yield ultimately. The prolonged period and pod forming and its compatibility with favorable environmental conditions can improve the number of pods per plant which is one of the main components of yield that can consequently increase the yield. However, it seems that the role of the indeterminate growth of chickpea also has no influence in this case.

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