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# INVIGORATION OF LENTIL (*Lens culinaris* L.) SEEDS BY HORMONAL PRIMING WITH KINETIN AND GIBBERELLIC ACID

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**ABSTRACT**

The present study was aimed to determine the effect of hormonal seed priming with gibberellic acid and kinetin on germination and seedling performance oflentil. Solution concentrations of gibberellic acid and kinetin were 0, 50, 100, 150 and 200 ppm. Dilute solution concentrations of hormones could not influenced earlier emergence of lentil. A further reduction in solution concentrations could delay mean emergence time. All the seed priming treatments also improved the coefficient of uniformity of emergence compared with non-primed seeds; however, maximum parameter value was recorded in solution concentrations of 150-200 ppm. Seedling vigor index responded positively and significantly to seed priming agents. The data shows that seedling vigor indexcan be increased by seed priming. Seed priming with higher doses of gibberellic acid and cytokinin may improve germination and vigorous performance of lentil. The stepwise regression analysis verified that the final emergence percentage, coefficient of uniformity of emergence and seedling dry weight had a marked increasing effect on seedling vigor index of lentil.

**Keywords:** gibberellic acid, increasing effect, invigoration, solution concentration.

## INTRODUCTION

Lentil (*Lens culinaris* L.) has been part of the human diet, also has the third-highest level of protein, after soybean and hemp. Lentil is deficient in two essential amino acids, methionine and cysteine. Lentil also contains dietary fiber, vitamin $B_1$, and minerals. Lentil is a good source of iron, having over half of a person's daily iron allowance in a one cup serving. Lentil is relatively tolerant to drought, and is grown throughout the world. The FAO reported that the world production of lentil for calendar year 2012 was 3.917 million tons. There is little information about hormonal methods of seed treatment onlentil. Priming could be defined as controlling the hydration level within seeds so that the metabolic activity necessary for germination can occur. Several different priming methods have been reported to be used commercially [1]. Farooq *et al*. [2] conducted a study to explore the possibility of yield improving in late sown wheat crop by seed priming.

In recent years, interest concerning the use of pre-treatment methods of seed priming due to their effects on plant growth improvement [3, 4, 5, 6]. Azadi *et al*. [7] showed that seed priming treatments significantly affected, germination percentage, germination index and means time to germination after aging. Priming with gibberellic acid (GA), salicylic acid (SA) and ascorbic acid (ASC) increased germination characteristics of aged seeds. In a study conducted by Mirshekari [8] those seeds treated in gibberellic acid and kinetin of 50-150 ppm germinated faster. Except of gibberellic acid and kinetin of 50 ppm, other treatments lead to lower seedling dry weight.

Therefore, the study aimed was to determine the effect of hormonal seed priming with GA and kinetin on speed of germination and seedling performance of lentil.

## MATERIALS AND METHODS

Laboratory and greenhouse experiments were conducted during 2014 on lentil. The seed priming tests of lentilwere performed in a completely randomized design, using solutions of GA and kinetin at five concentrations of 0, 50, 100, 150 and 200 ppm. There were three replications of each priming solution. Seeds were soaked in the required aqueous solutions of hormones. Twenty five primed seeds for each replicate were placed in germinator at 25±1 °C for a germination test in a Petri dish containing Whatman filter paper No. 1 that had been thoroughly moistened with water and germination was checked. Number of germinated seeds was recorded daily according to the seedling evaluation handbook of the Association of Official Seed Analysts [9].

In green house condition, final emergence percentage (FEP) was calculated as the cumulative number of emerged seeds by using equation (1), as described by Larsen and Andreasen [10].

$$FEP = \Sigma n / N \times 100 \quad (1)$$

Where, $n$ is the number of emerged seeds at each counting and $N$ is total seeds in each treatment.

Time taken of seedling to 50 % of emergence ($E_{50}$) was calculated according to the following formula of Coolbear *et al*. [11].

$$E_{50} = t_i + (N/2-n_i)(t_j-t_i)/n_j-n_i \quad \textit{Ecuación} \quad (2)$$

Where $N$ is the final number of emerged seeds, and $n_i$ and $n_j$ are the cumulative number of seeds emerged by adjacent counts at times $t_i$and $t_j$ when $n_i<N/2<n_j$.

Mean emergence time (*MET*) was calculated according to the equation 3[12]:

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$$MET= \Sigma Dn/ \Sigma n \quad (3)$$

Where $n$ is the number of seeds which emerged on day $D$, and $D$ is the number of days counted from the beginning of emergence.

Coefficient of uniformity of emergence (*CUE*) was calculated using the formula of Bewley and Black [13]:

$$CUE= \Sigma n/ \Sigma[(t - \bar{t})\times n] \quad (4)$$

Where $t$ is the time in days starting from day 0, the day of sowing, $n$ is the number of seeds completing emergence on day $t$ and $\bar{t}$ is equal to *MET*.

Seedling vigor index (*SVI*) based on seedling dry weight and seedling height were calculated according to Abdul-Baki and Anderson [14] by using equation (5).

$$SVI = SDW \times FEP \quad (5)$$

Where, *SDW*is seedlings dry weight of lentil.

In statistics, stepwise regression includes regression models in which the choice of predictive variables is carried out by an automatic procedure [15]. In this study, to formulate the relationship among six independent growth variables measured in our experiment for lentil crop with a dependent variable, multiple regression analysis was carried out for the final germination percentage (*FGP*) ($X_1$), *FEP*($X_2$), $E_{50}$($X_3$), *MET*($X_4$), *CUE* ($X_5$) and *SDW*($X_6$); and *SVI* as a dependent variable.

Furthermore, the stepwise regression analysis was also carried out for the data obtained to test the significance of the independent variables affecting the SVI.

## RESULTS AND DISCUSSIONS

Hormonal solution concentrations significantly affected FGP and FEP oflentil (Table-1). Higher concentrations of the seed priming agents increased FGP and FEP compared with control. When lentil seeds treated with150-200 ppm hormonal solution concentrations, FGP improved 43% and 52% respectively (Figure-1). Germination rate as well as growth of crop plants can be improved by priming [16, 17]. In green house condition the averaged FEP from hormone-primed seeds in 100-200 ppm solution concentrations was nearly 85%, but only 65% from 50 ppm and control treatments (Figure-2). Beneficial effect of seed priming on seedling emergence is consistent with the farmers' perceptions of its effects on some other plants such as cumin (*Cuminumcyminum* L.) and marigold (*Calendula officinalis* L.) [18].

Interaction of hormones and solution concentrations on $E_{50}$ of lentil was significant (Table-1). Dilute solution concentrations of both hormones could not influenced earlier emergence of lentil. Whereas, higher concentrations of hormones lead to faster emergence of seeds. In 200 ppm solution concentration GA was more effective than cytokinin on time taken of seedling to 50% of emergence (Figure-3). In another study Mirasnsari and Smith [19] understood that seed priming of *Hordeumvulgare* and *Raphanussativus* with GA and cytokinin lead to fastening of time to final germination. The data shows that MET can be reduced by seed priming with the same trend of time taken of seedling to 50 % of emergence as observed above. In the present study, a further reduction in solution concentrations could delay MET. All the seed priming treatments also improved the CUE compared with non-primed seeds; however, maximum CUE was recorded in solution concentrations of 150-200 ppm (Figure-4). A lot of works have recently been done on the invigoration of seeds [11, 20] that improves seed performance and provides faster and synchronized germination.

**Table-1.** Variance analysis of effect of hormonal priming on studied variables in lentil.

| SOV | df | FGP | FEP | $E_{50}$ | MET | CUE | SDW | SVI |
|---|---|---|---|---|---|---|---|---|
| | | Mean squares | | | | | | |
| Hormone | 1 | 21.58 | 52.21 | 2.85 | 14.55** | 1.21* | 9.56** | 213.36* |
| Solution concentration | 4 | 89.22* | 500.25** | 9.25** | 6.65** | 2.99* | 3.73* | 845.02** |
| Interaction | 4 | 42.603 | 70.25 | 3.19* | 6.53** | 2.10* | 3.86* | 864.122** |
| Error | 20 | 24.45 | 42.21 | 0.90 | 1.78 | 0.55 | 0.99 | 165.04 |
| CV (%) | - | 10.10 | 22.22 | 5.89 | 10.23 | 14.25 | 15.25 | 14.14 |

*, ** mean significant difference at 5% and 1% probability levels respectively.

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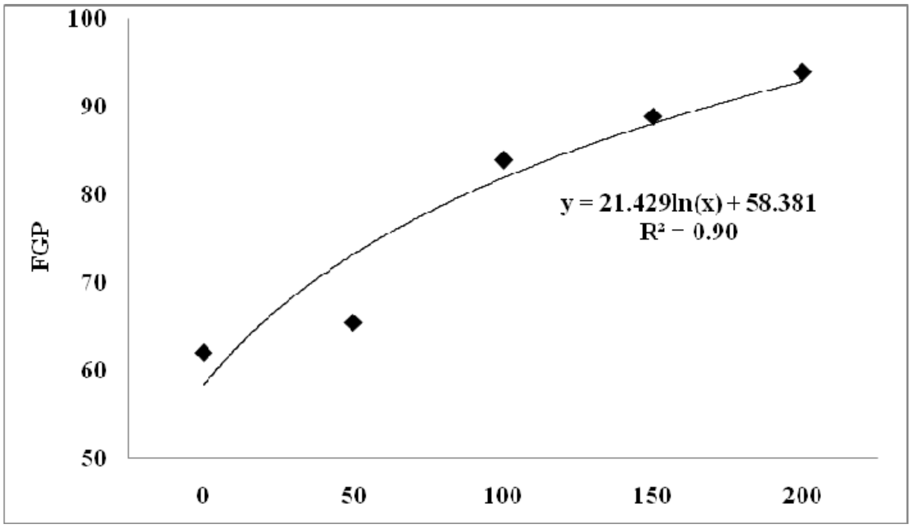
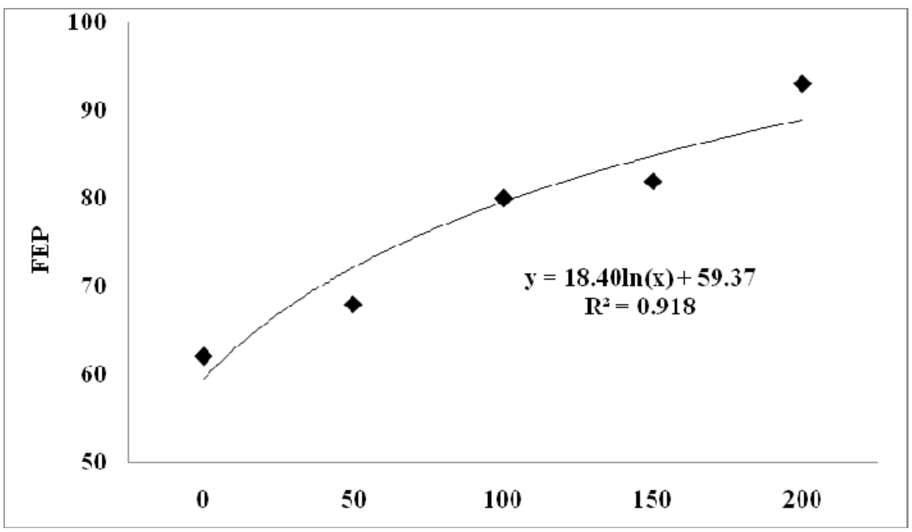



Hormonal solution concentrations (ppm)

**Figure-1.** Final germination percentage of lentil as affected by hormonal solution concentrations.




Hormonal solution concentrations (ppm)

**Figure-2.** Final emergence percentage of lentil as affected by hormonal solution concentrations.

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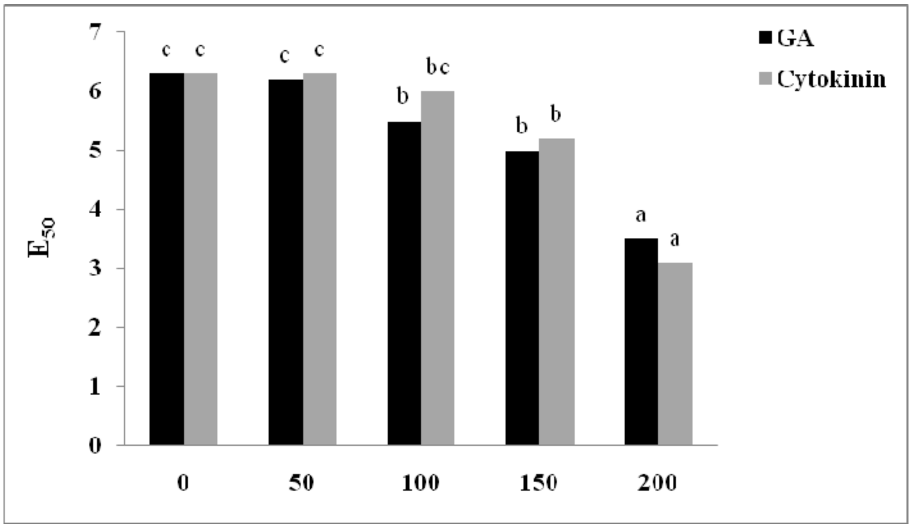
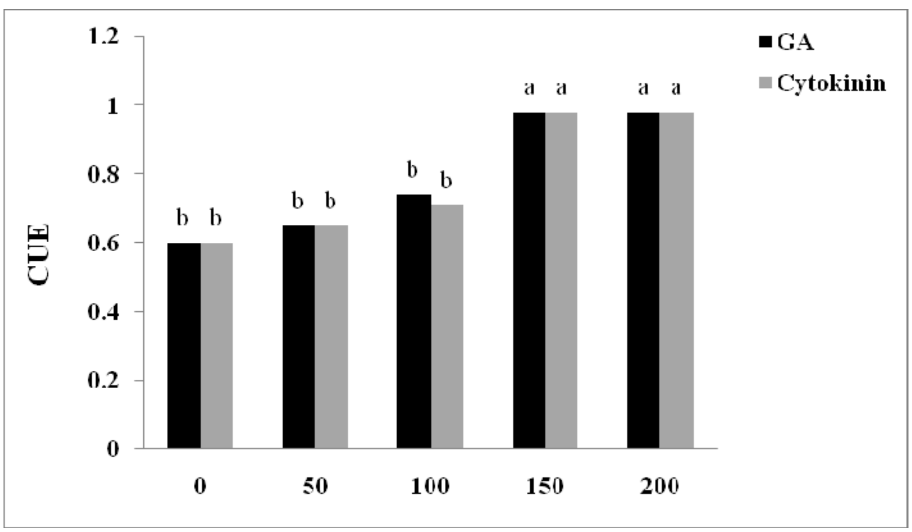



Hormonal solution concentrations (ppm)

**Figure-3.** Interaction of hormone and solution concentrations on $E_{50}$ in lentil.




Hormonal solution concentrations (ppm)

**Figure-4.** Interaction of hormone and solution concentrations on CUEin lentil.

Maximum SDW (0.92 g plant$^{-1}$) was noticed in 200 ppmtreatment of GA and cytokininfollowed by150 ppmtreatment of the solution concentration of both hormones (0.71 g plant$^{-1}$), and the lowest from non-treated seeds (0.39 g.plant$^{-1}$) and 50-100 ppm solution concentrations of GA (Figure-5). SVI responded positively and significantly to seed priming agents. The data shows that SVI can be increased by seed priming with the same trend of SDW as observed above. In the present study, a further reduction in solution concentrations of GA and cytokininfrom 150 ppm could restrict SVI. Producing non-vigorously seedlings was also registered for mung bean (*Viciaradiata*) when lower dosages of growth hormone solutions used for seed priming [21]. Besides, SVI from seeds treated with 50 ppm GA was found to be similar to that of control (Figure-6). Seed priming has been shown to enhance speed of germination, reduce the time between sowing to emergence, improves seedling vigor, stand establishment and increase yield [22]. The vigor of seeds can be improved by techniques generally known as seed priming, which enhance the speed and uniformity of germination, and finally yield attributes [23].

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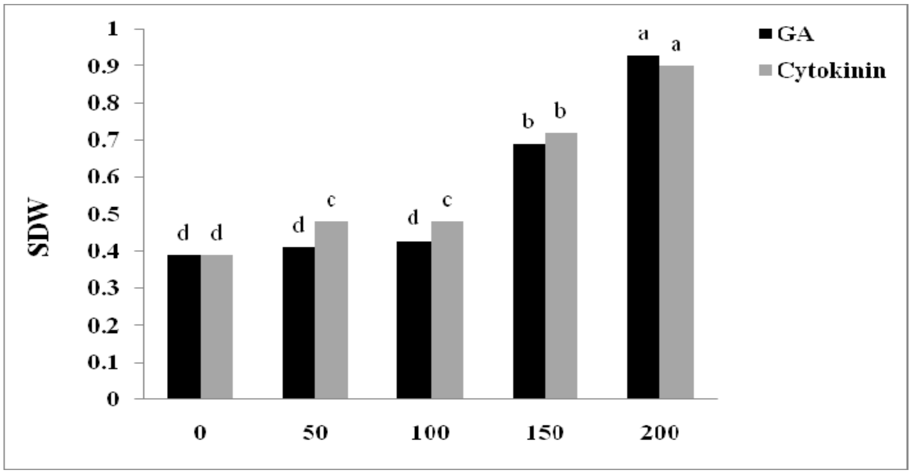
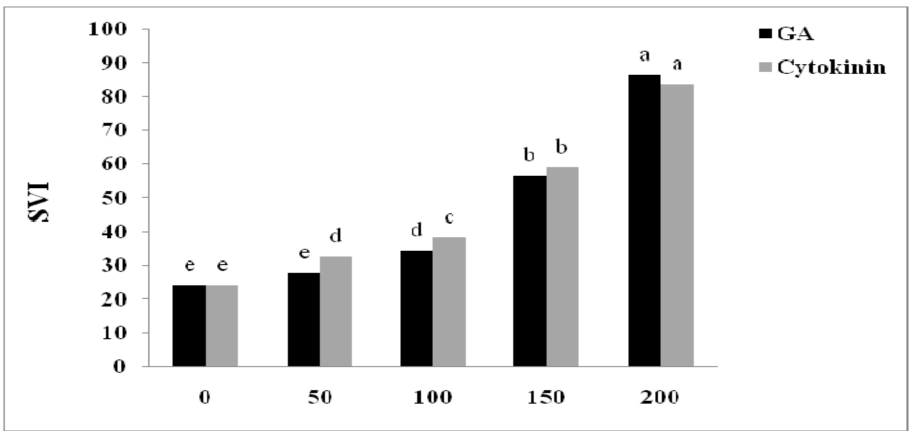



Hormonal solution concentrations (ppm)

**Figure-5.** Interaction of hormone and solution concentrations on SDWin lentil.




Hormonal solution concentrations (ppm)

**Figure-6.** Interaction of hormone and solution concentrations on SVIin lentil.

It is suggested that seed priming generally causes faster germination and field emergence, which have practical agronomic importance in crop production, especially under adverse environmental conditions [1]. In an experiment conducted by Mirshekari [8] wheat seeds primed before sowing with gibberellicacid and kinetin could be recommended due to faster growth.

**Stepwise regression analysis**

Standard regression coefficients, T values and probability levels of model of seedling vigor indexin lentil are indicated in Table-2. The resulted stepwise regression equation is as follows:

$$SVI= 3.102 + 5.11 (X_2) + 2.45 (X_5) + 4.121 (X_6);\ R^2 = 72 \quad (6)$$

**Table-2.** Standard regression coefficients, T values and probability levels of model of *SVI* in lentil.

| | FEP | CUE | SDW |
|---|---|---|---|
| Standard regression coefficients (β) | +1.410 | +0.856 | +0.734 |
| T values | +2.001 | +3.123 | +1.412 |
| prob. | 0.05 | 0.004 | 0.05 |

## CONCLUSIONS

As a conclusion, seed priming with higher doses of GA and cytokinin may improve germination and vigorous performance of lentil. The stepwise regression analysis verified that the final emergence percentage, coefficient of uniformity of emergence and seedling dry weight had a marked increasing effect on seedling vigor indexof lentil.

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