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# Influence of Different Irrigation and Potassium Levels on Water-Use-Efficiency of Potato in Calcareous Soil

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**A B S T R A C T**

The field experiment was conducted during the *rabi* season of 2005-2006 in Pusa Farm of Rajendra Agricultural University, Bihar in split plot design with sixteen treatment combinations consisting of four levels of irrigation and four levels of potash. Irrigation treatments were given after a common irrigation at 15 days after planting and 6 cm irrigation water was applied in each irrigations. Potato variety "Rajendra ALU- 3" was taken for present investigation. Total water requirement of $I_3$ (1.0 IW/CPE ratio) and $I_4$ (1.2IW/CPE ratio) levels of irrigation was higher than $I_1$ (0.6 IW/CPE ratio) and $I_2$ (0.8 IW/CPE ratio) levels of irrigation. The difference in water requirement between $I_3$ (1.0 IW/CPE ratio) and $I_4$ (1.2IW/CPE ratio) was not prominent because both these levels received three irrigation each. Likewise differences in between $I_3$ and $I_4$ were not prominent because both $I_3$ and $I_4$ irrigation levels received two irrigations. The water requirement was almost the same due to different levels of potassium. Significantly higher water use efficiency was in the treatment $I_2$ (0.8 IW/CPE ratio). Potassium level $K_2$ ($K_2O$ 100 kg $ha^{-1}$) also record significant highest water use efficiency.

## Introduction

Irrigation water is one of the costliest inputs used in crop cultivation. The primary attention centers round judicious use of irrigation water and improving water use efficiency to the highest possible limit. Thus, it is highly imperative to quantify "when and how much" irrigation should be given to harness optimum water use efficiency**.** Khalak and Kumaraswamy (1992) observed that the irrigation water given at frequent interval and in small quantity resulted in the improvement of growth attributes, dry matter accumulation and tuber yield in potato. Hukkeri and Sharma, 1979 concluded that potato could be subjected intermittently to mild stress once each at stolonization, early tuberization and tubes development which saved 30 percent of irrigation water without affecting the yield adversely, resulting in 33 to 41 percent higher production efficiency or irrigation water.

Potassium imports winter hardiness, develops disease and drought resistance, regulate stomatal movement and improve water use efficiency. Water stress causes a sharp increase in the concentration of abscisic acid in leaves and plant was supplied with K are associated with lower level of abscisic acid.

Thus, it is indicated that the response to potassium in limiting the soil moisture level may improve water use efficiency are thereby maintain crop yield (Hsiao, 1973). The efficiency of irrigation is enhanced by potassium and *vice-versa* showing an interaction effect between them.

In brief, the application of irrigation and potassium in optimum dose at proper time plays a very significant effect on overall production of potato.

## Materials and Methods

The field experiment was conducted during the *rabi* season of 2005-2006 at Pusa Farm of Rajendra Agricultural University. The details of the materials used and method adopted for carrying out the present study are described as below. The experimental site is located at 25°59' North latitude and 85°48' East longitude with an altitude of 52·92 meters above mean sea level (Table 1). The climate of the experimental area is sub-tropical with a mean annual precipitation of 1270 mm and mean annual temperature of 25.3°C. The experiment was laid out in a thrice replicated split plot design having four levels of irrigation *viz*., 0.6, 0.8, 1.0 and 1.2 IW/CPE ratio in the main plot four levels of potassium *viz*., no potassium, 50, 100, and 150 kg $K_2O$ $ha^{-1}$ in sub-plot.

Irrigation treatments were given after a common irrigation at 15 days after planting and 6 cm irrigation water was applied in each irrigation. The quantity of irrigation water required in each plot was measured by Parashall Fume having a throat width of 7.5 cm installed at the head of the experimental plot. Weather conditions during the crop season are presented in table 2. The total amounts of water applied under different treatment are present table 3. Water requirement and water use efficiency were calculated using the following formula

Water requirement (cm) = IR + ER + $\left[\Sigma \frac{Mbi-Mei}{100}\right]$ x BDi x Di

Where,

IR= Amount of irrigation water applied (cm)

ER= Effective rainfall during the season (cm)

n = Number of soil layer considered level in root zone depth D

Mbi = Soil moisture percentage at the start of season in the $i^{th}$ layer

Mei = Soil moisture percentage at the end of season in the $i^{th}$ layer

BDi = Soil bulk density in the $i^{th}$ level (g $cm^{-3}$)

Di = Depth of $i^{th}$ layer in root zone depth (cm)

Water use efficiency (kg/ha/cm) = $\frac{Y}{WR}$

Where,

Y = Tuber yield (kg/ha)
WR = Total water requirement (cm)

## Results and Discussion

### Water Requirement

The number, quantities of irrigation water applied, effective rainfall, soil profile contribution, total water requirement are presented in table 4. The mean worked out data for total water requirement in respect of different irrigation levels revealed that the differences between $I_1$ and $I_2$ was not prominent because both these levels received two irrigation each. The small differences were due to soil profile contribution.

Likewise, the differences in between $I_3$ and $I_4$ were not prominent because both $I_3$ and $I_4$ irrigation level received three irrigations each. These results are comparable with the finding of Banerjee and Saha, 1983 and Yadav *et al.*, 2003. Total water requirement worked out for $I_1$, $I_2$, $I_3$ and $I_4$ was 14.554 cm, 14.137 cm, 19.949 cm and 19.826 cm, respectively. The water requirement was almost the same due to different levels of potassium.

**Table.1** Physio-chemical properties of soil of experimental plot

| Sl. No. | Particulars | Value obtained |
|---|---|---|
| **1.** | Sand (%) | 46.85 |
| **2.** | Silt (%) | 41.35 |
| **3.** | Clay (%) | 11.8 |
| **4.** | Texture | Sandy loam |
| **5.** | Bulk density (g $cc^{-1}$) | 1.46 |
| **6.** | Bulk density (g $cc^{-1}$) | 2.56 |
| **7.** | Percent pore space | 43.00 |
| **8.** | Water holding capacity (%) | 31.12 |
| **9.** | pH (1:2 Soil: water) | 8.4 |
| **10.** | Electrical conductivity ($dSm^{-1}$) at 25$^{o}$C | 0.75 |
| **11.** | Organic carbon (%) | 0.40 |
| **12.** | Available N (kg $ha^{-1}$) | 222.0 |
| **13.** | Available $P_2O_5$ (kg $ha^{-1}$) | 19.0 |
| **14.** | Available $K_2O$ (kg $ha^{-1}$) | 117.8 |
| **15.** | CEC {Cmol (p+) $kg^{-1}$} | 9.21 |
| **16.** | Free $CaCO_3$ (%) | 24.0 |

**Table.2** Weather condition during the crop season

| Month | Temperature $^{o}$C | | Relative Humidity (%) at 7:0 AM | Relative Humidity (%) at 2:0 PM | Rainfall (mm) |
|---|---|---|---|---|---|
| | Maximum | Minimum | | | |
| **November, 2005** | 283. | 13.7 | 86.0 | 48.0 | 0.00 |
| **December, 2005** | 25.0 | 9.2 | 88.0 | 43.0 | 0.00 |
| **January, 2006** | 21.9 | 7.8 | 90.0 | 56.0 | 0.00 |
| **February, 2006** | 29.7 | 14.0 | 88.0 | 51.0 | 0.00 |

**Table.3** Total amount of water applied under different treatment

| Treatment | IW/CPE ratio | Number of irrigation | Irrigation water applied (cm) |
|---|---|---|---|
| **$I_1$** | 0.6 | **2** | **12** |
| **$I_2$** | 0.8 | **2** | **12** |
| **$I_3$** | 1.0 | **2** | **18** |
| **$I_4$** | 1.2 | **2** | **18** |

**Table.4** Total water requirement as affected by different treatments

| Treatments | No of irrigation | Irrigation water applied (cm) | Effective rainfall (cm) | Soil Profile contribution (cm) | Total water requirement (cm) | WUE (Kg/ha/cm) based on irrigation water applied |
|---|---|---|---|---|---|---|
| **Irrigation level** | | | | | | |
| **$I_1$** (IW/CPE ratio 0.6) | 2 | 12 | 0.0 | 2.554 | 14.554 | 1216.25 |
| **$I_2$** (IW/CPE ratio 0.8) | 2 | 12 | 0.0 | 2.137 | 14.137 | 1256.67 |
| **$I_3$** (IW/CPE ratio 1.0) | 3 | 18 | 0.0 | 1.949 | 19.949 | 903.44 |
| **$I_4$** (IW/CPE ratio 1.2) | 3 | 18 | 0.0 | 1.826 | 19.826 | 940.28 |

**Table.5** Water use efficiency as affected by different treatments

| Treatment | Water use efficiency(Kg/ha/cm) |
|---|---|
| **A. Irrigation levels** | |
| **$I_1$**(IW/CPE ratio 0.6) | 1002.83 |
| **$I_2$** (IW/CPE ratio 0.8) | 1066.69 |
| **$I_3$** (IW/CPE ratio 1.0) | 815.15 |
| **$I_4$**(IW/CPE ratio 1.2) | 853.65 |
| S. Em. $\pm$ | 15.27 |
| CD at 5% | 52.85 |
| **B. Potassium levels** | |
| **$K_0$** (0 kg $K_2O$/ha) | 835.77 |
| **$K_1$**(50 kg $K_2O$/ha) | 906.56 |
| **$K_2$** (100 kg $K_2O$/ha) | 969.76 |
| **$K_3$** (150 kg $K_2O$/ha) | 1026.24 |
| S.Em. $\pm$ | 21.42 |
| CD at 5% | 62.52 |
| **Interaction (I×K)** | |
| S. Em. $\pm$ | 42.84 |
| CD at 5% | NS |

## Water use - efficiency

The water use efficiency observed under the influence of different treatments (Table 5) revealed that the difference were significant highest water use efficiency of 1066.96 kg/ha/cm was recorded under the treatment $I_2$ receiving one irrigation after the one common irrigation followed by $I_1$ receiving the same number of irrigation. The lowest water use efficiency (815.15 kg/ha/cm) was noted under the treatment $I_3$ which was at par with the treatment $I_4$ (853.65 kg/ha/cm). There was significant difference in water use efficiency between $I_2$ and $I_3$ levels of irrigation. Among the potassium levels, Significant highest water use efficiency was recorded with $K_2$ (100 kg $K_2O$/ha) as compared to $K_1$ (50 kg $K_2O$/ha) and $K_O$ (control) but was at par with $K_3$ (150 kg $K_2O$/ha). Interaction effect was

found non-significant. These results are in of confirmity of the finding of Parihar and Sandhu, 1987 and Sharma and Dixit, 1992.

The difference in water requirement was not prominent because $I_1$ and$I_2$ are receiving two irrigations where as $I_3$ and $I_4$ receiving three irrigation each. The water requirement was almost same due to different levels in pot Treatment $I_2$ and $K_2$ recorded highest water use efficiency.

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