INFLUENCE OF IRRIGATION METHODS ALONG WITH NITROGEN AND POTASH MANAGEMENT ON YIELD AND NUTRIENT UPTAKE BY POTATO

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ABSTRACT

Field experiment was conducted during rabi seasons of 2006-07 and 2007-08 to study the effect of fertigation of nitrogen and potash under different methods of irrigation on yield of potato cv. Kennebec. Fifteen treatment combinations consisting of five irrigation methods viz., drip (0.8 PEF) with lateral in each row (45 cm) and in each pair (90 cm), micro-sprinkler (at 3 m) at 1.0 IW/CPE ratio (40 mm) and furrow at 0.8 IW/CPE ratio (60 mm) were relegated to main plots and three levels of fertility viz., 50%, 75% and 100% N and K of recommended dose were assigned to sub-plots, with three replications. Irrigation through drip (0.8 PEF) in each row and pair was found equally effective in increasing yield of potato. It also recorded higher values of NPK uptake, WUE, nutrient productivity, net realization and BCR. 75% recommended levels of nitrogen and potash in five equal splits at 28, 35, 49, 56 and 56 days after planting through fertigation (F₃) increased the yield, uptake of NPK, WUE, nutrient productivity, net realization and BCR. Growing of potato laying drip with laterals in each pair and applying 75% recommended dose of N and K (206 kg each) as fertigation in five splits resulted into higher tuber yield and uptake of nutrient, phosphorus and potash, WUE, nutrient productivity, net realization and BCR.

Key words: Drip irrigation, Fertigation, Irrigation, Potato.

INTRODUCTION

Potato is an important vegetable cash crop of Gujarat state. During last two decades it has occupied many new areas in the region. The crop fits well with existing cropping systems in the state. In recent years Gujarat has also come to be recognized as a potential area for potato exports. As a bulky vegetable, potato is increasingly being the choice for rural and urban poor struggling to have a two-square meal a day, and a high prices processed product, it is the choice snacks for the urban elites increasingly preferring the fast foods to conventional culinary dishes. Because of high protein-calorie ratio (17 g protein : 1000 KCal) and short vegetative cycle, potatoes yield substantially more edible energy, protein and dry matter per unit area and time than many other crop species. It is an ideal crop for making food in the shortest possible period of time in response to land scarcity propelled by high population pressure. Among the factors influencing potato production, supply of water and nutrients play a vital role, therefore, efficient use of nutrients for growth and development of plants under sandy loam soils having poor water retention capacity is very crucial. In potato cultivation, fertilizers and water are very costly inputs apart from seed. For economizing these inputs, the present investigation with different methods of irrigation and levels of fertility was carried out.

MATERIALS AND METHODS

An experiment was conducted at Fruit Research Station, S.D.A.U., Dehgam (Gandhinagar), Gujarat during rabi seasons of 2006-07 and 2007-08. The soil of the experimental plot was sandy loam rating low in available nitrogen (184.4 kg/ha), medium in available phosphorus (58.2 kg/ha) and available potash (257.9 kg/ha) with pH of 7.85. The experiment was laid out with fifteen treatment combinations in split plot design with five treatments of irrigation methods viz., I₁ : Drip (0.8 Pan Evaporation Fraction) with lateral in each row

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(45 cm), I₂ : Drip (0.8 PEF) with lateral in each pair (90 cm), I₃ : Irrigation through perforated pipes (90 cm), I₄ : Micro-sprinkler (laid at 3 m distance) at 1.0 IW/CPE (40 mm depth) and I₅ : Furrow irrigation at 0.8 IW/CPE (60 mm depth) as main plot treatments whereas, three fertility levels viz., F₁ : 50% recommended dose of N and K, F₂ : 75% recommended dose of N and K and F₃ : 100% recommended dose of N and K were assigned as sub plot treatments. Dripper discharge was 8 LPH for treatments I₁ and I₂. In I₄ treatment, discharge was 47 LPH. For above treatments operation pressure was maintained at 1.2 kg/cm². Kennebec variety of potato released for French fries and chips was selected as test crop in present investigation. The recommended dose of fertilizer to potato in Gujarat is 275-140-275 kg NPK/ha. FYM @ 25 t/ha was applied as basal to all the treatments. A common dose of phosphorus (140 kg/ha) along with 20 % N and K was applied as basal to all the treatments. Remaining 80% N (through urea) and K (through murate of potash) was applied in five equal splits at 28, 35, 42, 49 and 56 days after planting through drip in I₁, I₂ and I₃ treatments and manually in I₄ and I₅ treatments. A common irrigation of 50 mm was applied in all the treatments through conventional furrow method for uniform and rapid germination. In treatment I₁ and I₂, irrigation was applied on alternate day. In treatment I₅, continuous water supply was maintained. Eight irrigations were applied in I₁ treatment where as, in I₅ treatment four irrigations were applied.

**RESULTS AND DISCUSSION**

Effect of different irrigation methods was significant on tuber and haulm yield of potato during individual years and on pooled basis. Treatment I₁ recorded significantly higher tuber yield during 2006-07, 2007-08 and on pooled basis, respectively, but it was statistically at par with I₂ treatment in the year 2007-08. Highest tuber and haulm yield achieved under drip irrigation had contributed for more uptake of nitrogen. Higher values of nitrogen uptake with drip irrigation methods might be due to increase in solubility of nutrients with increasing water content in soil. The conductivity of the soil increases when soil moisture content is high and under such condition, mass flow transport of nutrients increases (Tisdale et al., 1985). Similar results were reported by Janat (2007). Treatment I₁ exhibited its significant superiority in terms of total phosphorus uptake over other irrigation methods during 2006-07 and in pooled analysis, but it was at par with I₂ treatment in the year 2007-08. The higher uptake of phosphorus under drip irrigation treatments (I₁ and I₂) might be due to sound root-soil relation, which provides rapid diffusion of ions by reducing the path length of ion movement on one hand and increase in elongation, turgidity and number of root hairs which ultimately, boost uptake on other hand. The present findings are supported by Singh et al. (2007). Total potassium uptake was significantly higher under I₁ treatment, but it was statistically at par with I₂ during both the years of experimentation as well as in pooled results. The results clearly suggested that movement of exchangeable potassium was more under adequate soil moisture condition which led to higher uptake of potash, but the water deficiency restricted the movement of potassium and ultimately result in poor uptake. Significantly higher water use efficiency was recorded under I₁ treatment, but it was at par with I₂. The magnitude of increase in WUE due to I₁ and I₂ treatment over I₄ and I₅ treatments was 59.19, 27.88 and 52.67, 22.64 per cent which clearly suggests the effective utilization of irrigation water. Constant available soil moisture in the root zone of plants with only 29 cm water through drip provided almost no-stress condition throughout crop season which might have created favourable micro climate for efficient use of other inputs and thereby, increased in yield. Similar findings were reported by Sasani et al. (2006). Nutrient productivity (kg/kg) was also
**TABLE 1.** Effect of different treatments on yield, economics and NPK uptake by potato (Pooled of two years).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total tuber yield (q/ha)</th>
<th>Haulm yield (q/ha)</th>
<th>Total N uptake (kg/ha)</th>
<th>Total P uptake (kg/ha)</th>
<th>Total K uptake (kg/ha)</th>
<th>WUE (kg/ha-mm)</th>
<th>Nutrient Realization (Pooled) (kg/kg)</th>
<th>BCR</th>
<th>Gross Net</th>
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<tr>
<td>Irrigation Methods</td>
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<td>I&lt;sub&gt;i&lt;/sub&gt; : Drip (0.8 PEF) with lateral in each row</td>
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<td>I&lt;sub&gt;3&lt;/sub&gt; : Irrigation through perforated pipes</td>
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<td>I&lt;sub&gt;4&lt;/sub&gt; : Micro-sprinkler at 1.0 IW/CPE (40 mm depth)</td>
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**Significance Levels:**

- F<sub>I</sub> : 50% RD
- N and K
- 75% RD
- N and K
- 100% RD
- N and K

**C.V. %**

- 7.99
- 12.86
- 10.79
- 7.35
- 12.86
- 10.57
- 9.76
- 11.06
- 10.47
- 10.28
- 7.81
- 9.04
- 7.35
- 9.98
- 8.79
- 8.12
- 13.67
- 11.32
- 6.20
- 4.10
influenced by irrigation methods. Highest nutrient productivity was recorded under $I_1$ treatment followed by $F_2$. The magnitude of increase was 27.85 and 22.63 per cent over surface method of irrigation. Highest gross realization of Rs. 122997/ha was registered under $I_1$ treatment followed by $I_2$ treatment (Rs. 1179587/ha). Highest net realization of Rs 46302/ha was registered under $I_1$ treatment followed by $I_2$ treatment (Rs. 39407/ha). The increase in net realization under $I_2$ treatment over $I_5$ (conventional method of irrigation) was to the tune of 39.54 per cent. Significantly higher BCR of 1.64 was realized under $I_2$ treatment (Drip with lateral in each pair).

A linear increase in N uptake was noticed with successive increase in level of N and K during both the years as well as in pooled data. Different fertility levels significantly influenced the total nitrogen uptake during 2006-07, 2007-08 and in pooled results. Treatment $F_3$ registered significantly higher values of N uptake during the study, but it was at par with $F_2$ during 2006-07. The magnitude of increase in N uptake due to $F_3$ and $F_2$ over $F_1$ treatment was to the tune of 41.84 and 31.35 per cent on pooled basis, respectively. The total phosphorus uptake by potato enhanced with increase in levels of N and K during the course of experimentation and on pooled basis. Treatment $F_3$ recorded significantly higher values of phosphorus uptake, but it was at par with $F_2$ treatment. The magnitude of increase in P uptake due to $F_3$ and $F_2$ over $F_1$ treatment was to the tune of 36.40 and 32.82 per cent on pooled basis, respectively. Increase in application of N and K increased the plant growth and dry matter accumulation in tubers, this induced absorption of higher amount of nitrogen and phosphorus from soil and subsequently accumulated in plant. Potash uptake by the crop was increased considerably with successive increase in fertility levels. The magnitude of increase in total potash uptake under higher fertility level $F_3$ was 40.43 and 29.75 per cent as compared to $F_1$ and $F_2$ treatments in pooled analysis, respectively. This might be due to excellent role of nitrogen and phosphorus in various metabolic processes, which ultimately led to succulent growth of plants and consequently resulted into higher uptake of potash. The above findings are supported by the findings of Singh et al. (2007). Linear increase in WUE was recorded with increase in level of N and K. Highest WUE was achieved with $F_3$ treatment followed by $F_2$ and $F_1$. The highest tuber yield and WUE under $F_3$ were probably due to optimum conditions created through fertigation and also due to higher availability of nutrients at critical stages of plant growth, leading to high cell division and elongation of cells in the tubers. Fertility levels also influenced nutrient productivity. Increase in fertility levels linearly decreased the nutrient productivity, the highest being under $F_1$ level. Highest gross realization (Rs. 112837/ha) was recorded under $F_3$ fertility level which was closely followed by $F_2$ level. The highest net realization was recorded under $F_2$ fertility level (Rs. 39668/ha) which was 50.80 and 1.79 per cent higher over $F_1$ and $F_3$ levels, respectively. Significantly higher BCR of 1.64 was realized under $I_2$ treatment (Drip with lateral in each pair). Treatment $F_3$ (75% of recommended N and K) recorded significantly higher BCR of 1.56, but it was at par with $F_3$ (100% of recommended N and K). The interaction effect of irrigation methods and fertility levels was significant on net realization and BCR (Table 2). Significantly higher net realization of Rs. 53838/ha

<table>
<thead>
<tr>
<th>Irrigation methods</th>
<th>Fertility levels</th>
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<tr>
<td>$I_1$ : Drip (0.8 PEF) with lateral in each row</td>
<td>$F_1$ : 50% RD N and K</td>
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<tr>
<td>$I_2$ : Drip (0.8 PEF) with lateral in each pair</td>
<td>$F_2$ : 75% RD N and K</td>
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<tr>
<td>$I_1$ : Irrigation through perforated pipes</td>
<td>$F_3$ : 100% RD N and K</td>
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N.B. Figures in the parentheses are BCR values.
was registered under treatment combination $I_2F_3$ (Drip in each pair + 100 % RD of N and K) which was statistically at par with treatment combination $I_2F_2$ (Rs. 53511/ha, Drip in each pair + 75% Rd of N and K). Significantly higher BCR (1.75) was recorded under treatment combination $I_2F_2$, but it was statistically at par with treatment combination $I_2F_3$ (1.73).

Based on the above findings, it can be concluded that for higher yield, net realization, BCR and uptake of potato cv. Kennabec be irrigated with drip irrigation (0.8 PEF) with laterals in each pair (90 cm apart) with 75% recommended levels of nitrogen and potash to be applied in five equal splits at 28, 35, 42, 49 and 56 days after planting through fertigation in light textured soil of North Gujarat.

REFERENCES