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## 5. SUMMARY AND CONCLUSIONS

Field experiments were conducted during the two successive seasons of 2002 and 2003 to investigate the effects of soil moisture (manifested as irrigation scheduling) and K fertilizer on growth, yield, NPK nutrients in plant, tuber quality and water use. The crop was grown on an alluvial clay loam soil in El-Qanater Horticulture Research Station, Qalyubia, Governorate, Egypt.

Irrigation treatments were expressed as evaporation pan coefficient (EF) values were as follows:  $G_1 = EF\ 0.8$ ,  $G_2 = EF\ 1.0$ , and  $G_3 = EF\ 1.2$ . In terms of moisture status of soil,  $G_3$  is considered the most moist, and  $G_1$  is considered the least moist. In terms of irrigation scheduling,  $G_1$  is of the longest intervals between irrigations. Fertilizer K treatments were:  $K_1$ ,  $K_2$  and  $K_3$  applied either in 2 equal splits ( $M_2$ ) or as one dose ( $M_1$ ). Application rates of K (kg K/f) were as follows:  $K_1 = 100$ ,  $K_2 = 133$  and  $K_3 = 166$

### **1- Plant height:**

Plant height (in cm) increased with increased moisture giving heights of 69.2, 61.88, and 53.86 cm for  $G_1$ ,  $G_2$ , and  $G_3$  respectively. The  $K_3$  gave the highest plant height (64.89) and  $K_1$  gave the lowest (57.94). The K effect was manifested when  $K_2$  and  $K_3$  gave plants greater height over  $K_1$ . Splitting gave plants of more height than the one-dose application.

## **2- Weight of fresh matter (g/plant), of 90-day growth:**

Fresh weight plant (g/plant) was as follows:  $G_3$  (280) >  $G_2$  (268) >  $G_1$  (158). Where potassium was at the medium  $K_2$  rate,  $G_2$  resembled  $G_3$  fertilizer treatments. The non-fertilized plants were lower in weight than the fertilized ones. Average values for the fertilized showed  $K_3$  (256) >  $K_2$  (245) >  $K_1$  (231). The superiority of  $G_3$  was most effective where K was at its highest rate and added in one dose. Under  $G_1$  all  $K_1$ ,  $K_2$ , and  $K_3$  were rather similar in effect.

## **3- Tuber dry weight (g/plant):**

Mean values showed  $G_3$  (134) >  $G_2$  (129) >  $G_1$  (120). Under conditions of  $K_1$ , the two irrigation schedules of  $G_2$  and  $G_3$  were similar, but under  $K_2$  or  $K_3$  the  $G_3$  treatment was superior reflecting a necessity of presence of a high K rate for the high moisture to be efficient. The highest tuber dry weight among the fertilizer treatments was given by  $K_3$  then by  $K_2$ ; the pattern was:  $K_3$  (135) >  $K_2$  (131) >  $K_1$  (120). The  $M_2$  was superior to  $M_1$ .

## **4 -Total tubers yield per Fadden (Mg/f " mega grams per Fadden ")**

Main values showed  $G_3$  (10.54) >  $G_2$  (9.26) >  $G_1$  (7.23) the  $G_2$  and  $G_3$  were similar under conditions of  $K_1$  particularly where K was applied in one dose; otherwise  $G_3$  was superior to  $G_2$  yield increased by increased K application the main effect

shows;  $K_3$  (9.68) >  $K_2$  (9.10) >  $K_1$  (8.26). With the low moisture regime of  $G_1$  the  $K_2$  and  $K_3$  were similar when applied split.

## **5 - N, P and K in plant of 90-day growth**

In many cases there was a " dilution effect "

### **A- Nitrogen content (g/kg):**

Main effect shows  $G_1$  (23.8) >  $G_3$  (21.9) >  $G_2$  (21.3). The 3 treatments were of similar effect where K rate was medium to high. K-fertilization showed  $K_1 = 21.7$ ,  $K_2 = 23.2$  and  $K_3 = 22.1$  g/kg. The  $K_2$  treatment showed superiority over  $K_1$  and  $K_3$  under condition the medium  $G_2$  irrigation treatment.

### **B-Phosphorus content (g/kg):**

Main effect of irrigation shows  $G_1 = 2.41$ ,  $G_2 = 2.58$ , and  $G_3 = 2.46$ . Treatment and  $G_2$  was particularly superior where K was highest and applied as split.

### **C- Potassium content (g/kg)**

Main effect of irrigation treatments shows:  $G_1 = 27.47$ ,  $G_2 = 27.86$  and  $G_3 = 28.61$ . Superiority of  $G_2$  over  $G_1$  or  $G_3$  was only where K was applied at its lowest  $K_1$  rate. Under conditions of the highest  $K_3$  all of G treatments were similar. Effect of K fertilization shows that  $K_1$  gave less potassium

content, while highest potassium content was that of  $K_3$  or  $K_2$  by both of which were similar in effect. Mean values were  $K_1 = 27.44$ ,  $K_2 = 28.07$  and  $K_3 = 28.43$ . The split application was superior to the one – dose application. Under conditions of  $G_3$  all K rate was rather similar.

## **6 -Nutrient uptake by potato plant ( kg / f )**

### **A- Nitrogen uptake ( kg N/f ):**

Effect of irrigation shows that  $G_2$  gave the highest N-uptake followed by  $G_3$ , then  $G_1$  with no difference between  $G_2$  and  $G_3$ . Average N-uptake by plants were  $G_1 = 29.81$ ,  $G_2 = 37.36$ ,  $G_3 = 36.30$ . The  $G_2$  treatment was superior to  $G_3$  under conditions of  $K_3$  where K was applied in one dose. The highest uptake of N among the fertilized treatments was given by  $K_3 = 37.88$  followed by  $K_2 = 35.26$ . The lowest was by  $K_1 = 30.33$ . The  $M_2$  treatment gave greater uptake than the  $M_1$  treatment. Under conditions of  $G_1$  and  $G_2$  there were no significant differences among the 3 K rates of addition.

### **B-Phosphorus uptake (kg P/f):**

Main effect of irrigation shows lowest P- uptake, by  $G_1$  (6.77), while the highest was given by  $G_3$  or  $G_2$  (8.40 each). The  $G_3$  was superior to  $G_2$  under conditions of  $K_3$  where K was applied split. Mean values regarding K treatments were (7.17),



(7.93) and (8.45) Kg P\ fed by applying  $K_1$ ,  $K_2$ , and  $K_3$  respectively; and  $M_2$  was superior to  $M_1$ . All K rates were similar under conditions of  $G_2$ .

### **C- Potassium uptake (kg K/f)**

Main effect of irrigation shows that the wet  $G_3$  gave the highest K- uptake followed by medium  $G_2$ , then the dry  $G_1$  treatment. Mean values of K- uptake by plants were :  $G_3 = 45.97$ ,  $G_2 = 41.03$  and  $G_1 = 35.54$  . The greatest K- uptake was by  $K_3$  with averages as follows: 44.20, 41.56 and 36.78 kg K/f by  $K_3$ ,  $K_2$  and  $K_1$  respectively. The  $M_2$  gave higher K uptake than the  $M_1$  method. Superiority of  $K_3$  over  $K_2$  was particularly under conditions  $G_1$  or  $G_2$  but not  $G_3$  .

### **7-Tuber quality of potato plants.**

Quality was expressed by contents of total soluble solids TSS in potato sap, protein, and starch contents in potato tuber.

### **A -Total soluble solids (TSS) in potato sap.**

The greatest TSS was given by wet  $G_3$ , followed by  $G_2$  and the lowest was by  $G_1$ . Mean values (g/L) were as follows:  $G_1 = 42.93$ ,  $G_2 = 43.48$   $G_3 = 46.81$ . Applied K at  $K_2$  or  $K_3$  showed similar results, and both surpassed  $K_1$ ; mean values were  $K_1 = 43.91$ ,  $K_2 = 44.50$  and  $K_3 = 44.80$  g/L.

## **B -Starch content (g/kg) in fresh tubers.**

Mean values of starch content (g/kg) were as follows;  $G_1 = 155.1$   $G_2 = 193.8$   $G_3 = 185.4$  with  $G_2$  and  $G_3$  showing no significant differences between them. Although  $G_2$  was similar to  $G_3$  on the whole (as main effect),  $G_2$  surpassed  $G_3$  under conditions of  $K_1$ . The  $K_1$  gave lower starch than  $K_2$  or  $K_3$  both of which were similar in effect. Mean values were as follows:  $K_1 = 167.0$ ,  $K_2 = 179.0$ ,  $K_3 = 188.3$ .

## **C-Protein content (g/kg).**

There was no significant differences between  $G_2$  and  $G_3$  with both giving similar effect followed by  $G_1$ . Mean values were :  $G_1 = 74.3$ ,  $G_2 = 83.8$ ,  $G_3 = 81.4$ . Under conditions of  $K_1$  or  $K_2$  there was no significant difference between  $G_1$ ,  $G_2$ , or  $G_3$ .  $K_3$  gave highest protein content and  $K_1$  gave lowest. Mean values were: 83.3, 80.8 and 75.4 g/kg by  $K_1$ ,  $K_2$ , and  $K_3$  respectively. Under conditions of  $G_1$  or  $G_3$  there was no significant difference between  $K_1$ ,  $K_2$  or  $K_3$ .

## **8-Consumptive use (CU) " mm":**

The  $G_3$  regime gave the highest consumptive use followed by  $G_2$ , then  $G_1$ . Mean values (mm) were as follows :  $G_3 = 466.9$ ,  $G_2 = 431.6$  and  $G_1 = 365.8$ . The highest consumptive use was by  $K_3$  followed by  $K_2$  then  $K_1$  with means (mm) of: 430.0, 421.1 and 413.2 by  $K_3$ ,  $K_2$  and  $K_1$  respectively.

## **9 - Comparing actual ET with calculated ET:**

Under conditions of the carries using the modified Penmen equation could be recommended to estimate the crop evapotranspiration (ET<sub>c</sub>) from the agroclimatological data. Accordingly, estimated ET<sub>c</sub> of potato were 455.9 mm, while the overall average of the actual consumptive use, measured by the soil moisture depletion method, was 432 mm.

## **10 -Water use efficiency (WUE)**

The G<sub>3</sub> gave the highest water use efficiency followed by G<sub>2</sub>, then G<sub>1</sub>. Mean WUE values (kg tubers/m<sup>3</sup> irrigation water) were as follows: G<sub>3</sub> = 5.389, G<sub>2</sub> = 5.112 and G<sub>1</sub> = 4.705 kg/m<sup>3</sup>. Superiority of G<sub>3</sub> over G<sub>2</sub>, however was significant only where the rate was K<sub>2</sub> or K<sub>3</sub>. The highest WUE was that of K<sub>3</sub> and the lowest was that of K<sub>1</sub>. Mean values were as 4.755, 5.121, and 5.331 kg/m<sup>3</sup> for K<sub>1</sub>, K<sub>2</sub>, and K<sub>3</sub> respectively. The M<sub>2</sub> showed greater WUE over the M<sub>1</sub> treatment.

## **11- Fertilizer use efficiency " FUE " (of fertilizer K):**

The FUE was calculated in terms of kg tubers of excess yield due to K-fertilization per one kg of applied fertilizer K. The G<sub>3</sub> gave the highest FUE followed by G<sub>2</sub> then G<sub>1</sub> with means of 15.06, 19.21, and 21.43 given by G<sub>1</sub>, G<sub>2</sub> and G<sub>3</sub> respectively. The K<sub>2</sub> and K<sub>3</sub> were similar and both surpassed K<sub>1</sub> with means (in kg potato tubers/kg of fertilizer K) of 17.34, 19.36, and 19.00 for K<sub>1</sub>, K<sub>2</sub>, and K<sub>3</sub> respectively.