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_3 (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 different 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 then. 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 fellows: 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) where 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 (ETc) from the agroclimatological data. Accordingly, estimated ETc 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_3 gave the highest water use efficiency followed by G_2, then G_1. Mean WUE values (kg tubers/m^3 irrigation water) were as follows: G_3 = 5.389, G_2 = 5.112 and G_1 = 4.705 kg/m^3. Superiority of G_3 over G_2, however was significant only where the rate was K_2 or K_3. The highest WUE was that of K_3 and the lowest was that of K_1. Mean values were as 4.755, 5.121, and 5.331 kg/m^3 for K_1, K_2, and K_3 respectively. The M_2 showed greater WUE over the M_1 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_3 gave the highest FUE followed by G_2 then G_1 with means of 15.06, 19.21, and 21.43 given by G_1, G_2 and G_3 respectively. The K_2 and K_3 were similar and both surpassed K_1 with means (in kg potato tubers/kg of fertilizer K) of 17.34, 19.36, and 19.00 for K_1, K_2, and K_3 respectively.