Evaluation of Potassium Status of Greenhouses in West Mediterranean Region/Turkey

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Introduction

- Potassium is an essential plant mineral element having a significant influence on human-health related quality compound in fruits and vegetables. Potassium is often referred as the quality element for crop production (Usherwood,1985).

- Potassium enhances storage and shipping quality of bananas, tomatoes, potatoes, onions and many other crops, and also extends their shelf life (Usherwood,1985; Geraldson,1985; Koo,1985; Von Uexkll, 1985; Bhargava et al., 1993; Mengel,1997).

- The crucial importance of potassium in quality formation stems from its role in promoting synthesis of photosynthates and their transport to fruits, grains, tubers, and storage organs and to enhance their conversion into starch, protein, vitamins, oil etc. (Mengel and Kirkby, 1987). With a shortage of potassium many metabolic processes are affected, like the rate of photosynthesis, the rate of translocation and enzyme systems (Marschner, 1995; Mengel, 1997).

- Relative to other nutrients, K is the plant nutrient taken up by vegetables in the highest rates (Imas, 1999). Therefore, in greenhouse vegetable production, balanced K nutrition of plants is important, especially for resistance against stress conditions, plant pathogens and insects.

- Forty seven percent of vegetable greenhouses of Turkey is located in Antalya region and 96% of greenhouses are used for vegetable growing. Of the vegetables greenhouses, 47% is used for tomato, 32% for cucumber, 9% for pepper, and 7% for eggplant production (Titiz,2004).

Materals and Methods

- In this presentation, data obtained from our previous studies of potassium and nitrogen status of tomato and cucumber plants and potassium status of soils in greenhouses of Antalya region in different years were combined and evaluated.

- Soil samples were taken according to Jackson (1967) from different greenhouse locations in 0-20 cm and 20-40 cm depth. Exchangeable potassium concentrations of the soils were extracted with ammonium acetate at pH 7.0 and determined by the Atomic Absorption Spectrophotometry (Kacar,1995). Results were classified based on Pizer (1967).

- Plant leaf samples were digested with HNO_3 and $HClO_4$ (4:1) acid mixture on a hot plate. Total potassium concentrations were measured by the Atomic Absorption Spectrophotometry (Kacar,1972). Total nitrogen concentrations were determined by a modified Kjeldahl Procedure (Kacar,1972).

- The potassium and nitrogen concentrations of tomato and cucumber leaves were classified based on Campbell (2000).

Results and Discussions

Tomato Greenhouses

- The tomato soils were found to change between very low and very high levels of exchangeable potassium. 73.4% of the soils were found to contain good, high and very high levels of exchangeable potassium.

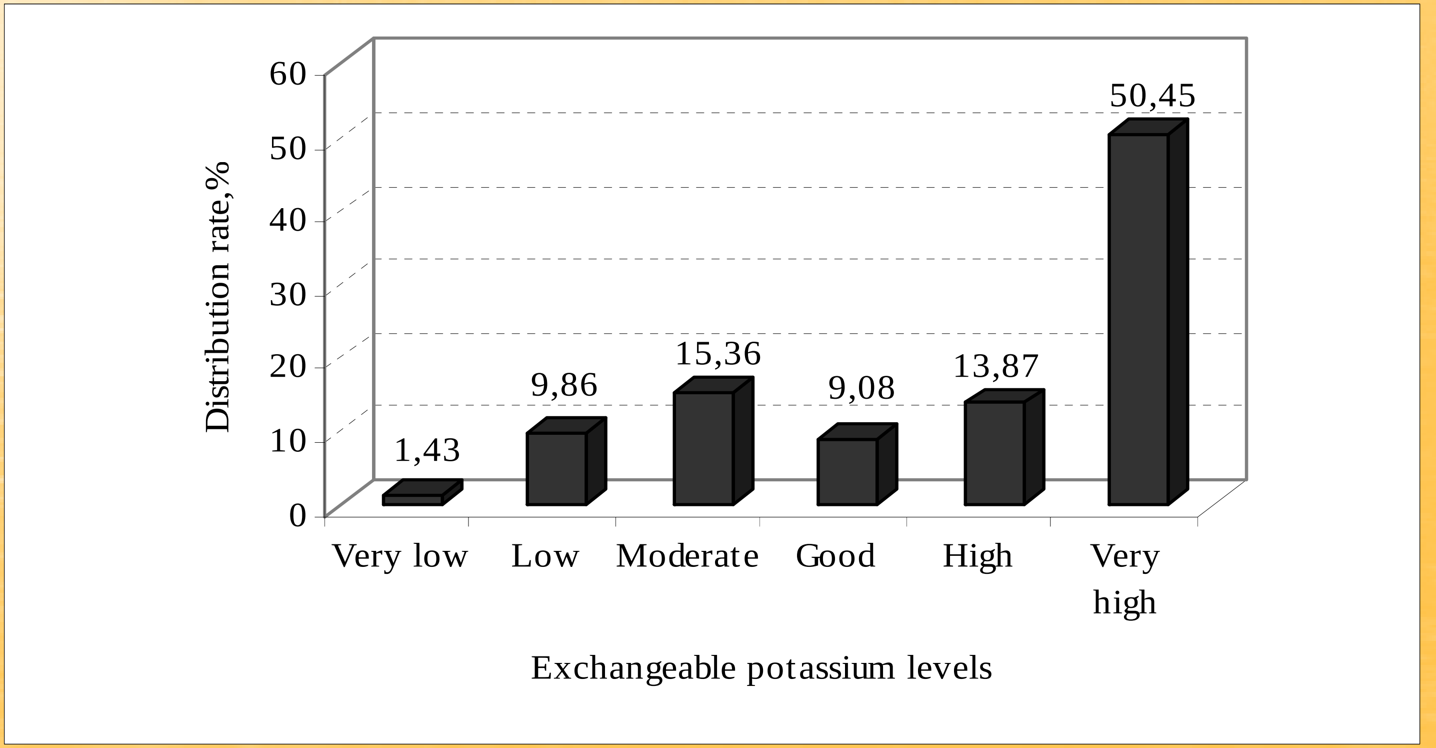


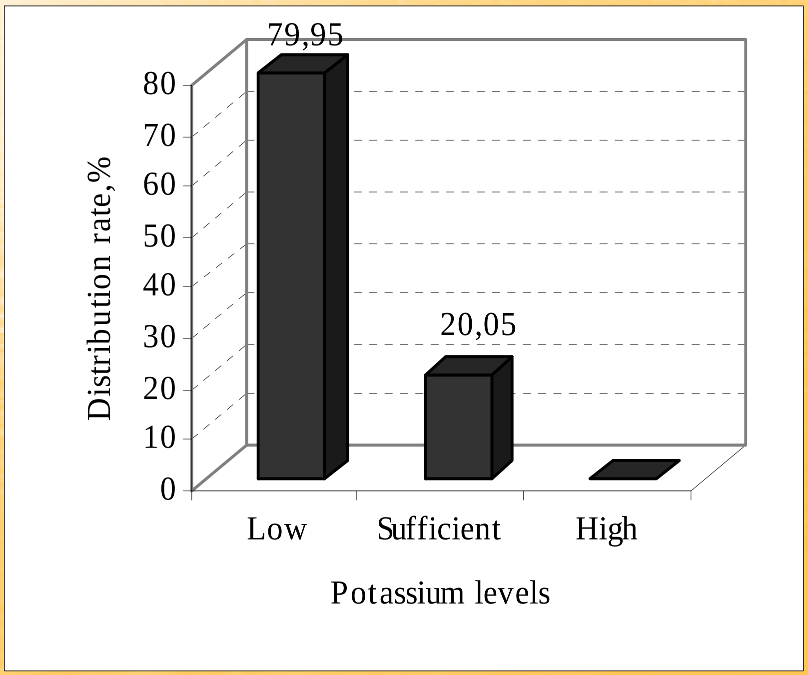
Figure 1. Distribution rate of exchangeable K levels of tomato greenhouse soils as average of each year

- In 1995, K concentrations of tomato leaf samples were found to change between 1.40% and 3.89%, N concentrations were found to change between 3.19% and 5.67%. In 2004, these values were found to be between 1.32% and 4.11%, and 2.79% and 4.99% for potassium and nitrogen concentrations, respectively.

Table 2.Distribution of potassium and nitrogen concentrations of tomato leaf samples in 1995 and 2004

Nutrient Element	Classification	1995	2004
		%	%
K (%)	Low (3.5 >)	72.4	87.5
	Sufficient (3.5-4.5)	27.6	12.5
	High (4.5 <)	-	-
N (%)	Low (3.5>)	2.86	22.5
	Sufficient (3.5-5.0)	80.0	77.5
	High (5.0 <)	17.14	-
Minimum K, %		1.40	1.32
Maximum K, %		3.89	4.11
Minimum N, %		3.19	2.79
Maximum N, %		5.67	4.99

- 79.95% of the tomato leaf samples were found to contain low and 20.05% contain sufficient levels of potassium. 12.68% of the leaf samples were found to contain low, 78.75% contain sufficient and 8.57% contain high levels of nitrogen. These values show that while tomato leaf samples do not have adequate level of potassium, they have adequate level of nitrogen (Figure 2).



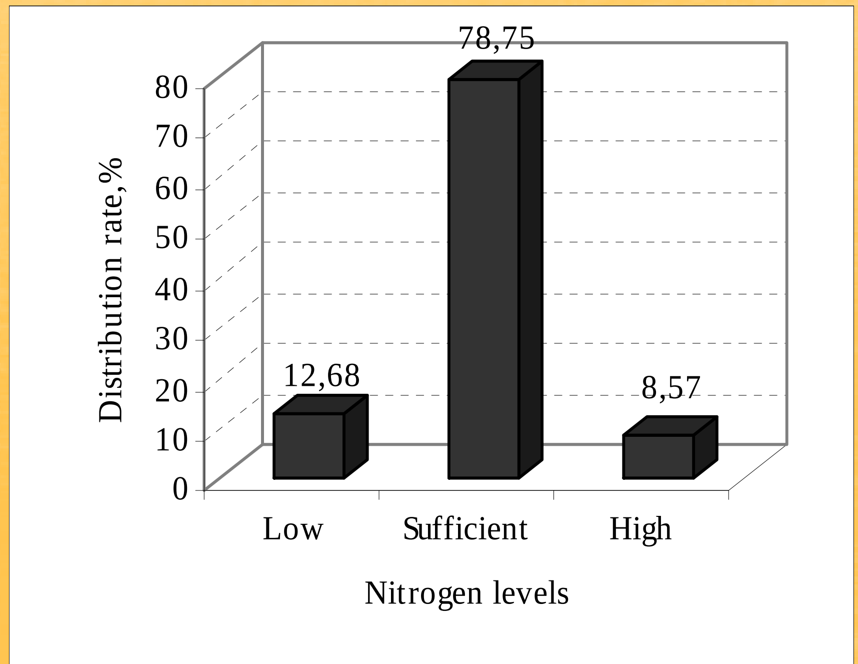


Figure 2. Distribution rate of K and N levels of tomato leaf samples as average of each year

Cucumber greenhouses

- The cucumber soils were found to have exchangeable potassium in between very low and very high levels. 94.58% of the soils were found to contain good, high and very high levels of exchangeable potassium (Figure 3).

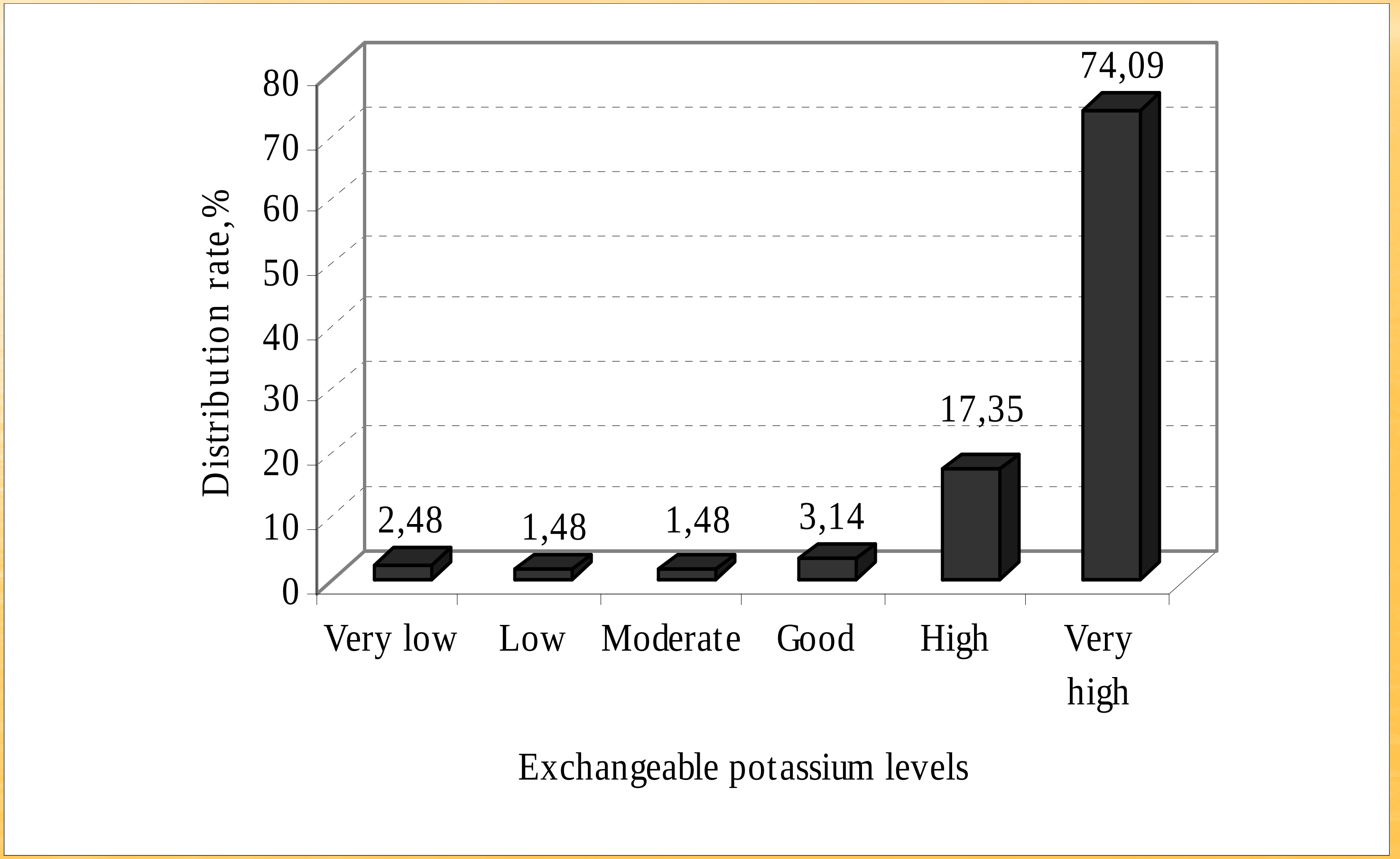


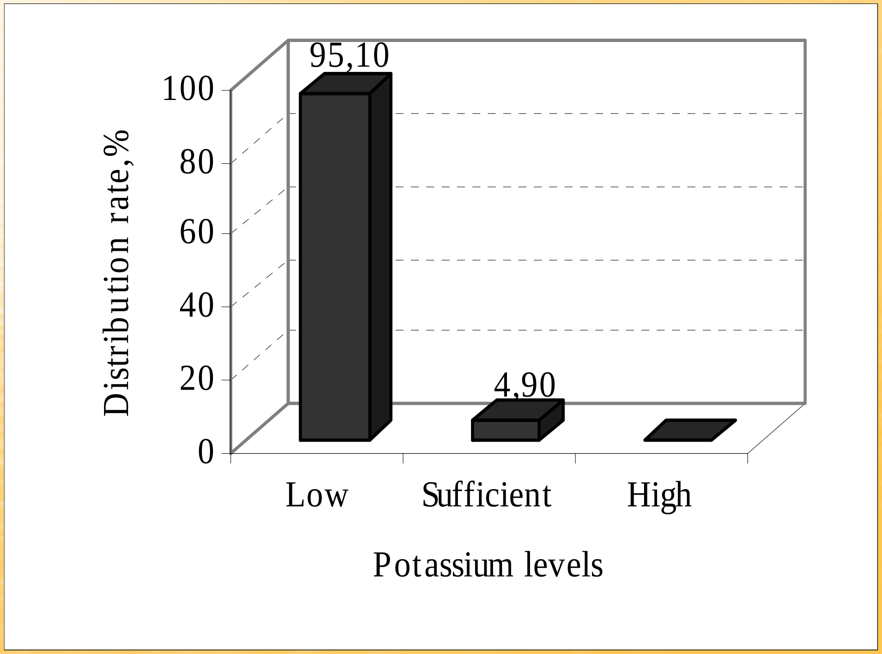
Figure 3. Distribution rate of exchangeable K levels of cucumber greenhouse soils as average of each year

- In 1993, K concentrations of cucumber leaf samples were found to change between 1.58% and 3.00%, N concentrations were found to change between 3.67% and 5.12%. In 1995, these values were found to be between 1.69% and 3.96% for K, and 4.61% and 6.70% for N (Table 4).

Table 4.Distribution of potassium and nitrogen concentrations of cucumber leaf samples in 1993 and 1995

Nutrient Element	Classification	1993	1995
		%	%
K (%)	Low (3.5 >)	100	90.20
	Sufficient (3.5-4.5)	-	9.80
	High (4.5 <)	-	-
N (%)	Low (4.5>)	86.67	-
	Sufficient (4.5-6.0)	13.33	96.08
	High (6.0 <)	-	3.92
Minimum K, %		1.58	1.69
Maximum K, %		3.00	3.96
Minimum N, %		3.67	4.61
Maximum N, %		5.12	6.70

- 95.10% of the cucumber leaf samples were found to contain low and 4.9% contain sufficient levels of potassium. 43.34% of the leaf samples were found to contain low, 54.71% contain sufficient and 1.96% contain high levels of nitrogen (Figure 4).



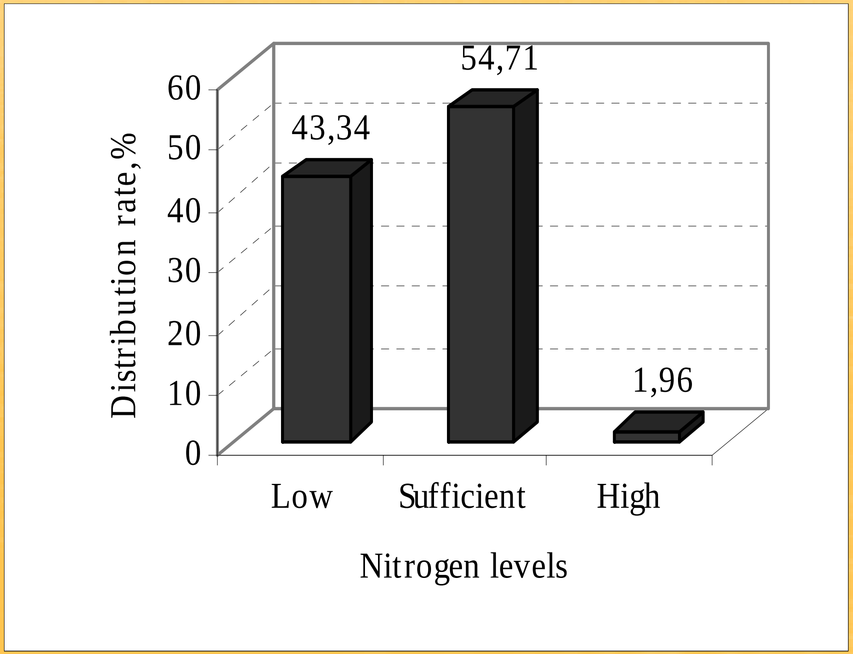


Figure 4. Distribution rate of K and N levels of cucumber leaf samples as average of each year

- N:K ratio of tomato in 1995 was between 0.99-3.09, in 2004 0.86-2.95; of cucumber in 1993 was between 1.31-3.20, in 1995 1.40-3.13 (Table7).

Table 7. The minimum, maximum and mean values of N:K ratios of tomato and cucumber leaves

N:K Ratio	Tomato		Cucumber	
	1995	2004	1993	1995
Minimum	0.99	0.86	1.31	1.40
Maximum	3.09	2.95	3.20	3.13
Mean	1.48	1.51	1.98	1.88

- Especially for fruit quality, ratios among nutrients should be taken into consideration in vegetables. N:K ratio is important for plant water balance and fruit quality.

- For example, excess nitrogen is characterized by lengthened internodes and “bullish” growth in the top of the plant. In severe cases, fruit set is adversely affected. The N:K ratio appears to be more important than nitrogen concentration in limiting the effects of high nitrogen. A N:K ratio of 1.2 to 1.8 is desirable for tomato and cucumber (Campbell,2000).

- Based on the N:K ratio of 1.2-1.8, 69.7% of the tomato leaf samples and 46.45% of the cucumber leaf samples were found to be in the range of 1.2-1.8. (Figure 7). Especially, in cucumber, an imbalance in N:K ratio exists. Nitrogen accumulates in plant tissues in case of K deficiency. When available nitrogen for microorganisms increase, risk of plant diseases is also elevated (Roorda van Eysinga and Smilde 1981; Bennet, 1994). When NH_4-N is used as N fertilizer, K uptake of cucumber plant decrease (Winsor and Adams, 1987).

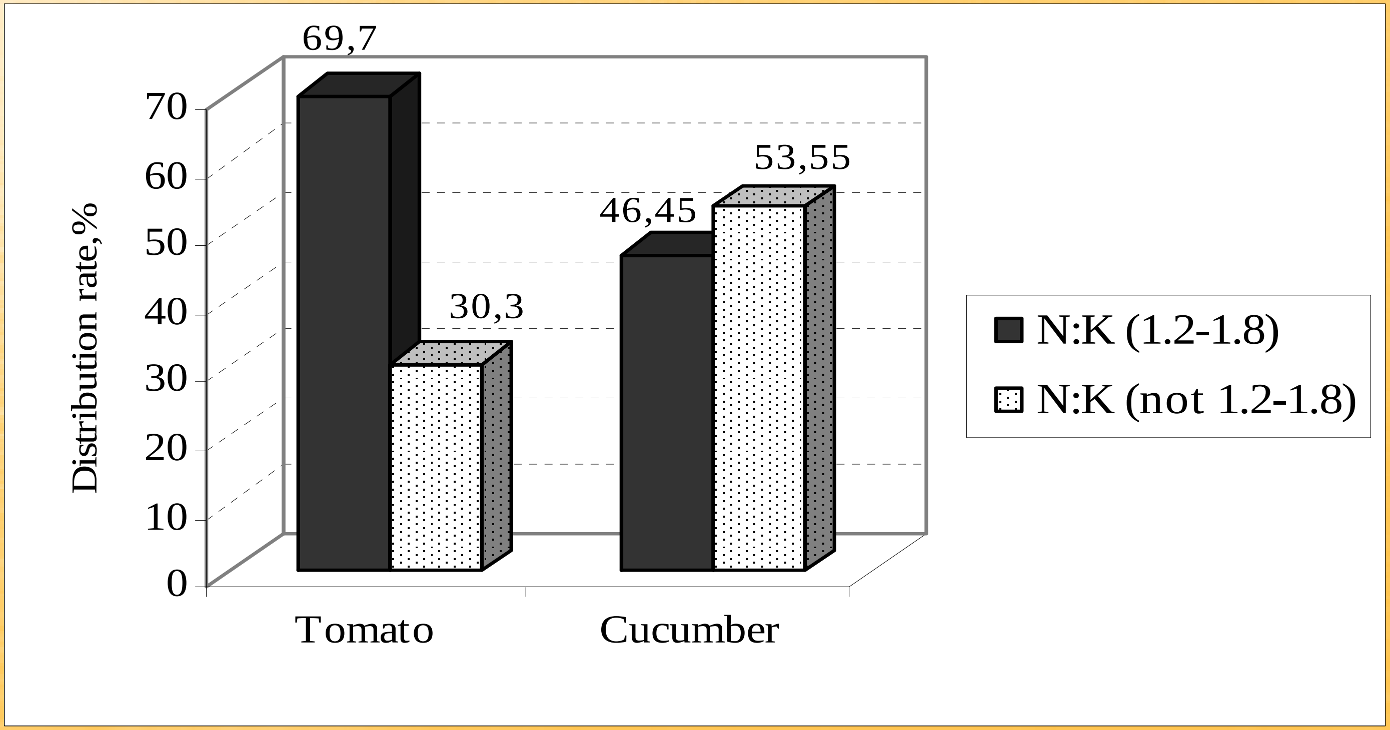


Figure 7. Distribution rate of N:K ratios of tomato and cucumber leaf samples

Conclusions

- Even though our soils have high level of K, due to N fertilization in high doses, N:K balance may change against K, triggering K deficiency in plants. Therefore, when N level in plants increase, it is also necessary to increase K level in order to maintain the balance. Monitoring the N:K ratio through plant analysis is very important especially for high quality cultivation.

- Even though greenhouse soils in our region have high level of K, K contents of plants were found to be in low levels. This suggest that critical values used for classification of soil exchangeable K is not suitable for such studies. Therefore, new studies are needed to determine new critical values for classification of soil exchangeable potassium.

- Considering the fact that greenhouse soils and irrigation waters in our region show high salinity, special attention should be given to K fertilization since K, which takes part in balancing water budget, is important in prevention of physiological drought in plants grown in such conditions.

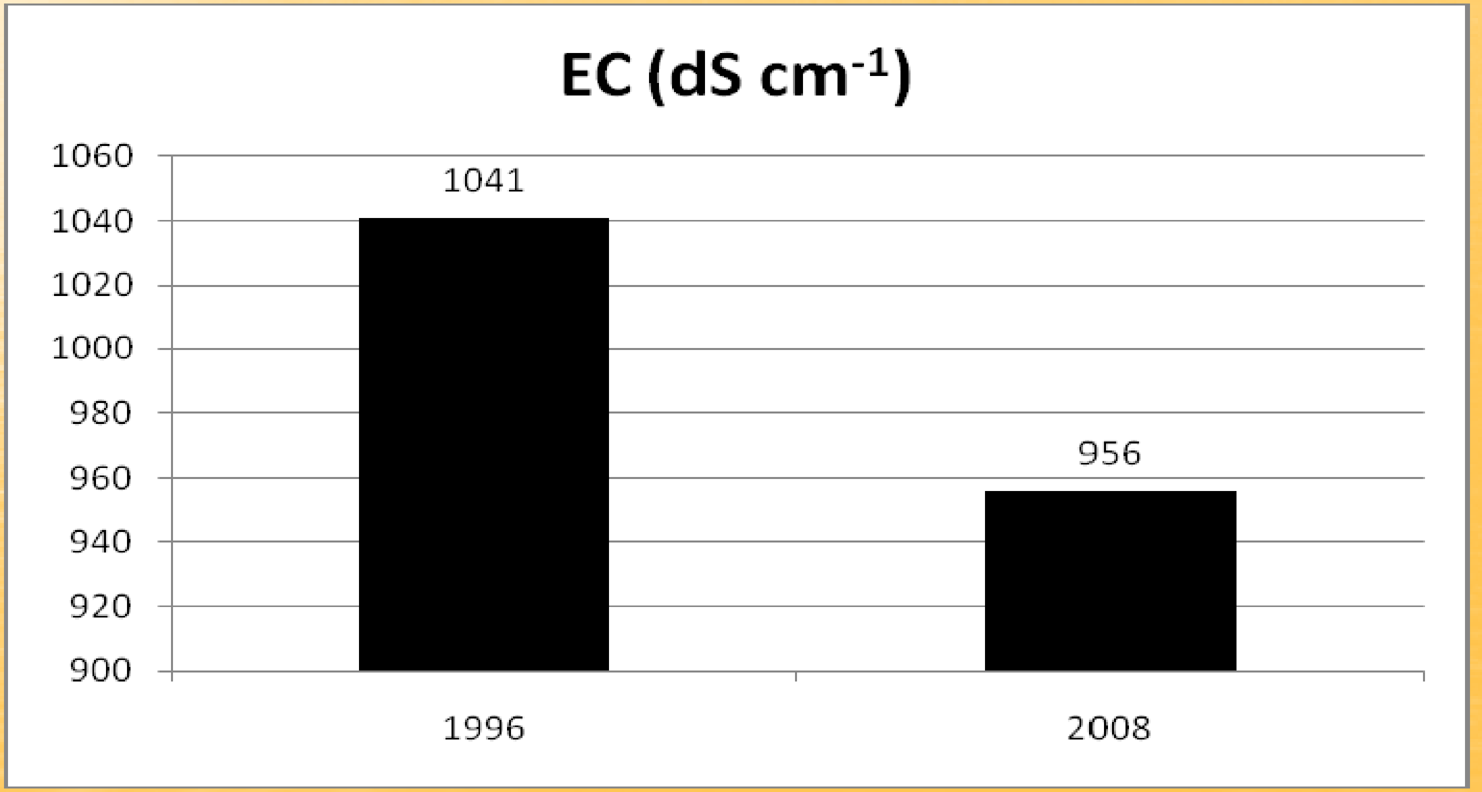


Figure 8. The changes of average EC values at irrigation waters obtained from the wells in Kumluca district in Antalya/Turkey (Orman et.al 2010)

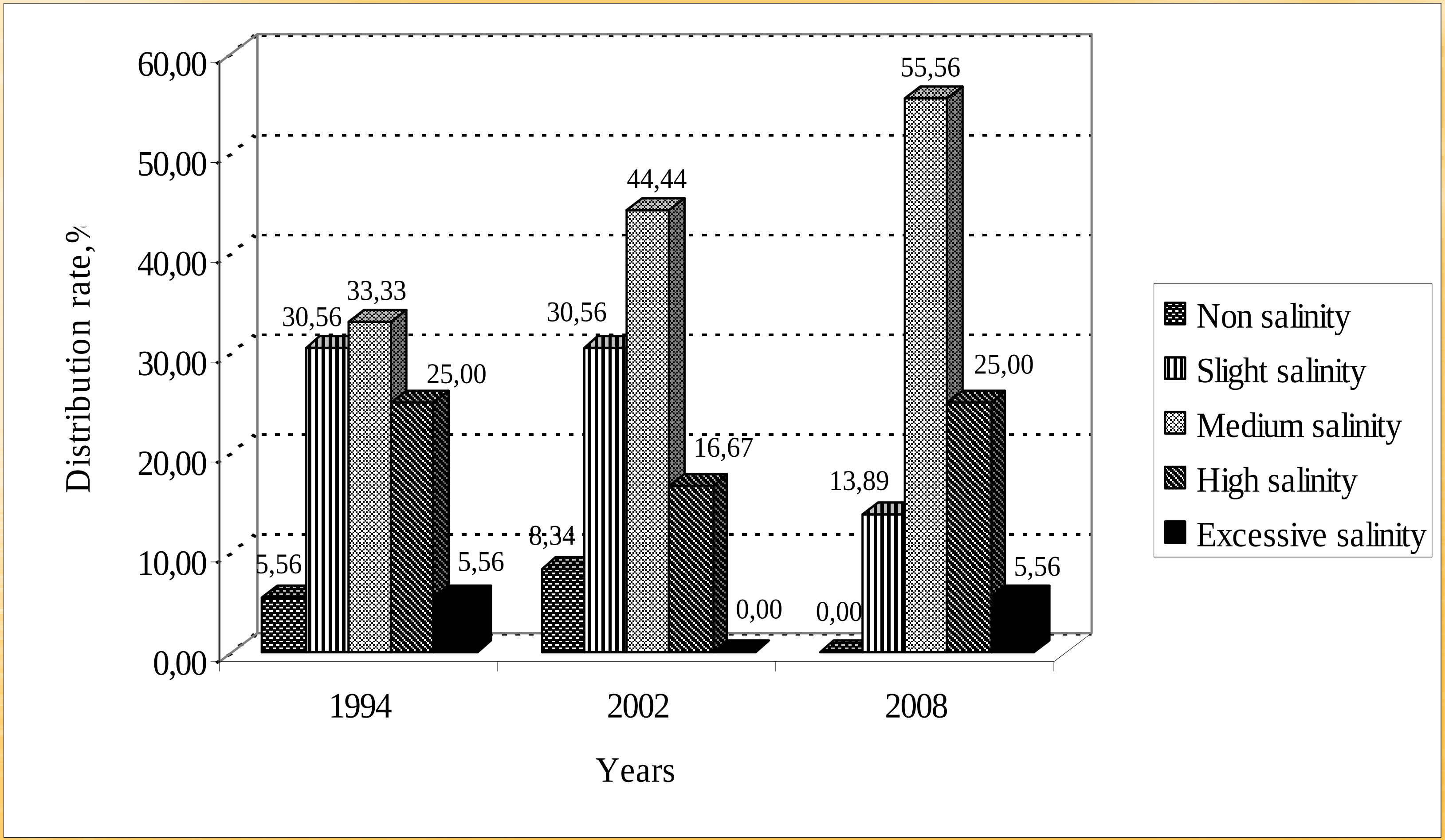


Figure 9. Distribution rate of salinity in Kumluca district greenhouse soils in Antalya/Turkey (Orman et.al 2008)

- Soils in our region have also high level of Ca and Mg concentrations preventing K uptake. Therefore, further studies should be conducted on applications increasing K uptake by plants.

THANK YOU VERY MUCH FOR YOUR INTEREST