Research Findings

III Preliminary Field Observations on the Response of Wheat and Barley to High Rates of K Fertilization in Rainfed and Irrigated Regions in Lebanon

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Introduction

The role of potassium (K) as an essential nutrient for agricultural crops is well established. Uptake of potassium is frequently as high as or even higher than that of nitrogen (N) (Mengel and Kirkby, 2001). About 50 enzymes, including those responsible for energy transfer and the formation of sugars, starch and proteins are activated by potassium so that its supply to the plant and its cellular concentration within the plant are of major importance (Krauss, 1997; Drast, 1992).

Adequate potassium nutrition results in superior quality cereal plants because of improved efficiency of photosynthesis, increased resistance to some diseases, and greater water use efficiency. It also helps maintain a satisfactory balance between carbohydrates and protein and, in addition, strengthens cereal straw and favors grain filling.

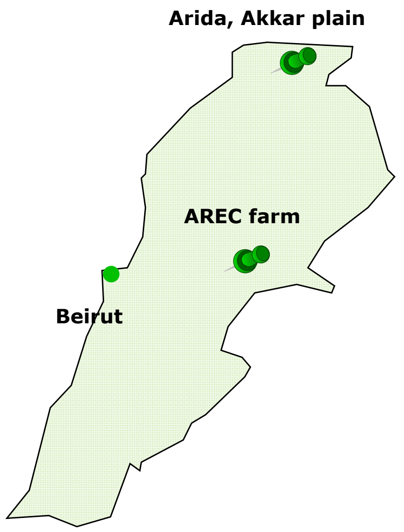
Older literature from Lebanon (Ryan and Hamze, 1981) indicates a lack of response of cereal crops to added potassium fertilizers on Bekaa clay soils containing 200 mg available K/kg soil. Recent investigations on K availability in Lebanese soils, however, has provided evidence of a possible positive response to K fertilization in Akkar soils, which are low in K content (Al-Zubaidi *et al.*, 2008a and 2008b). Recently, Darwish *et al.* (2007) also reported that in clay soils, potato responded to K application even when soil testing showed an available value close to 300 mg K/kg soil. Similarly, Al-Zubaidi (2003) observed that high doses of potassium were found to be beneficial for barley in some Iraqi soils.

There is limited information regarding the response of cereals to high rates of potassium fertilization in different Lebanese soils. The purpose of this field work was therefore to test the response of wheat to potassium application in irrigated soils of the Beqaa valley and the response of wheat and barley in rainfed soils of the Akkar plain in Lebanon (see map).

Field Trial No. 1: Response of irrigated wheat in the Beqaa Valley

A field experiment was conducted in the Beqaa area at the American Research and Educational Center (AREC) of the American University of Beirut (AUB), 80 km east of Beirut. Some physical and chemical properties of the soil (Table 1) were determined according to the methods described by Richards (1954). Different potassium forms (water-soluble: H_2O-K; potassium extracted by NH_4OAC: Exch-K; and potassium extracted by nitric acid: Acid-K) were determined by the methods described by Pratt (1965). The concentration of potassium in all extracts was measured by flame photometry.

The trial was carried out during 2006-2007. Each of the plots was 100 m^2. The fertilization treatments were as indicated in Table 2. At harvest, the grain was collected, weighed and yields of treatments compared.



Map of Lebanon with the experimental sites.

Table 1. Soil properties at AREC farm, Beqaa Valley.

Parameter	Unit	Value
EC	dS/m	0.28
pH	-	7.67
CEC	cmol/kg	31.0
$CaCO_3$	%	29.7
OM	%	2.6
Exch. cations		
Ca	mg/kg	5,670
Mg	mg/kg	274
Texture class	-	Clay
Potassium		
H_2O-K	mg/kg	4.5
Exch.-K	mg/kg	575
Acid-K	mg/kg	1,460
K-saturation	%	7.7

Table 2. Fertilization treatments applied in both locations.

Treatment	N-P_2O_5-K_2O	Fertilization
	---kg/ha---	
Control	0	0
N	170-0-0	810 ammonium sulphate
NP	170-170-0	810 ammonium sulphate + 350 superphosphate
NPK1	170-170-170	1,000 compound fertilizer (17-17-17)
NPK2	170-170-340	1,000 compound fertilizer (17-17-17) + 340 of potassium sulphate
NPK3	170-170-510	1,000 compound fertilizer (17-17-17) + 680 of potassium sulphate

Note: In addition to these nutrients, 100 kg N/ha was applied at the tillering/elongation stage in all treatments.

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Results

The yield of wheat (grain) in kg/ha in different treatments is shown in Table 3.

The data shows that there was a marked increase in the grain yield of wheat in the treatments which received N-P or N-P-K in comparison with the control and N only treatment. The increase in the yield of wheat was observed, in particular, in treatments NPK2 and NPK3, which received double and triple doses of potassium fertilizers (340 and 510 kg K_2O/ha, respectively). This shows that applying high rates of potassium could be beneficial for wheat production in this region. We suggest that using 17-17-17 compound fertilizer (1000 kg/ha) for wheat may not supply enough potassium for maximum yield. It is also worth mentioning that the analysis of soil samples after harvest showed that the application of K fertilizer increased the amounts of water-soluble K, and exchangeable-K as well as in the ratio of exch-K/exch. Ca+Mg, indicating that the application of K-fertilizer had a positive residual effect on soil potassium (results not shown).

The results of a second experiment which were repeated during 2007-2008 at AREC farm confirmed the observations made during 2006-2007: there was a clear response of wheat to potassium fertilizer application in treatments NPK2 and NPK3, which received double and triple doses of potassium as compared to NPK1 treatment (Table 4). These findings also clearly indicate that the affect on yield was brought about by an increase in the 1000 grain weight.

Table 3. Yield of wheat (kg/ha) in different treatments, AREC farm.

Treatment	Yield
	kg/ha
Control	344
N	659
NP	1,496
NPK1	1,437
NPK2	1,888
NPK3	2,171

Table 4. Yield of wheat in different treatment for the year 2007-2008, AREC farm.

Treatment	Yield	1000 grain weight
	mt/ha	*gr*
NPK1	4.40	171
NPK2	5.07	181
NPK3	5.27	212

Table 5. Soil properties at Arida, Akkar plain.

Parameter	Unit	Value
EC	dS/m	0.34
pH	-	8.0
CEC	cmol/kg	29.0
$CaCO_3$	%	3.75
OM	%	2.65
Texture class	-	Sandy clay loam
Exch. cations		
Ca	mg/kg	3,560
Mg	mg/kg	793
K	mg/kg	45

Field trial No. 2: Response of rained wheat and barley at Akkar Plain

The response of high K fertilization under rainfed conditions was carried out in a field trial on rainfed farmers' fields in Arida, Akkar plain, North Lebanon during 2006-2007. The fertilization treatments were the same as those shown in Table 2. The area of each plot was one dunam (1,000 m^2). Soil properties are outlined in Table 5.

Results

This field observation was carried out on a large scale (one dunum for each treatment) in the farmers' fields. The relative yields were used for comparing the effect of each treatment with that of the control as indicated in Table 6. The results show that, in general, wheat responded much more to fertilization than barley. The greatest response of both crops was to treatment NPK2 (170 kg N, 170 kg P_2O_5 and 340 kg K_2O per ha) which received a double dose of potassium as compared to that of NPK1. In the case of wheat, the yield was 6.71 mt/ha (2 mt/ha or 43.4 per cent greater than the control) and for barley 4.64 mt/ha (only 0.6 mt/ha or 15 per cent greater than the control). At the highest rate of potassium application, treatment NPK3, the yield response of both wheat and barley declined, probably because of the nutrient imbalance introduced in this treatment. It was also observed that the wheat and barley straw in treatments NPK2 and NPK3 were taller and thicker than in the other treatments.

Conclusions

A positive response to doubling the rate of K fertilization was observed at both the Beqaa and Akkar Plain field trials. The increase in yield for wheat in the two field trials ranged between 20-26 per cent when comparing yield of NP to NPK2 treatments. For barley, however, the increase in yield was about 10 per cent when comparing NP to NPK2 treatments.

Under present international prices of wheat and barley (US$180-200/mt), expenditure on such an increase in potassium use may not be economically viable. But should international prices of cereals increase, such as occurred in 2008 to US$600-800/mt, then farmers should give due attention to the positive response of large applications of potash fertilization for cereals in Lebanese soils.

Table 6. Yields of rainfed wheat and barley crops, Arida, Akkar.

Treatment No	Yield		Relative Yield	
	Wheat	Barley	Wheat	Barley
	---------------*mt/ha*---------------		---------------%---------------	
Control	4.68	4.03	100.0	100.0
N	5.30	4.10	113.3	101.7
NP	5.59	4.23	119.4	104.5
NPK1	5.98	4.13	127.8	102.5
NPK2	6.71	4.64	143.4	115.2
NPK3	5.66	4.35	121.0	107.9

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The paper "Preliminary Field Observations on the Response of Wheat and Barley to High Rates of K Fertilization in Rainfed and Irrigated Regions in Lebanon" appears also at:

Regional Activities/West Asia and North Africa (WANA)

Papers from Lebanon

The following publications, papers and presentations from Lebanon appear on the IPI website:

1. **Evaluations of K Availability in Selected Soils from Lebanon.** Al-Zubaidi, S. Yanni, and I. Bashour. 2008. *e-ifc* No. 15, March 2008. View paper.
2. **Fertigation and Conventional Potassium Application to Field Grown Potato in Lebanon: Perspective to Enhance Efficiency.** Darwish, T., T. Atallah, N. Khatib, and F. Karam. 2004. Presented at the Potassium and Fertigation Development in WANA, Marrakesh, Morocco. View paper.
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