LANDLAB SRL

L A N D L A B

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PNA – Potassium Nitrate Association

Wheat trial 2013/2014; KCl application + PN foliar

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Aim of the trial
Is the evaluation of the impact of two PN applications, in spring, on winter wheat fertilized with KCl at base dressing, four K levels, with respectively 0%, 50%, 75% and 100% of the supposed K removal based on the expected yield of 6,5-7,0 mt/ha.

The area of the trial has not been fertilized in the last two years: wheat was cultivated, grain and straw removed.

The soil has been amended, at the end of October 2013, with 20%-25% of silica sand (ø 0-2 mm) mixed in the first 20-25 cm of soil.

Short description of the trial (as in the agreed protocol)
Plots size: the plots were : 2,0 m x 3,0 m = 6 sqm

Entries: 4 K levels (0%-50%-75%-100% of FP) with KCl application and **with foliar PN** application (KNO_3 10kg/Ha in 400 liter of water)
4 K levels (0%-50%-75%-100% of FP) with KCl application and **no PN** application

where 100 % K is 96,0 kg/ha of K_2O, 75 % is 72,0 kg/ha , 50% 48,0 kg/ha and 0% is 0,0 kg/ha.

Nutrition:
- N base dressing at sowing time (20 % of the N removal, according with the expected yield ≈ 6,5- 7,0 ton/ha); standard N application is around 150 kg N/ha

- Two N split application (urea), (80% of the N removal), at the end of February and/or end of March according with the climate and soil conditions.
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Trial design
Randomized block with main block: with/without PN application
Replications : n. 5

Total n. of plots: 8 x 5 = 40

The assessments have been conducted according with the protocol of the trial.

The “check list” below is summarizing the key events of the trial.

CLIENT	PNA			
TRIAL NAME	309PNA13			
TRIAL DESCRIPTION				
Localization	LANDLAB RESEARCH STATION		coordinate	lat.45.37, long. 11.37
TRIAL PROTOCOL				
N. of entries	4			
N. of replication	5			
Randomized block	(description)	Main block: with/without PN foliar		
Name entries	Description of the entries			
1	0 K			
2	50 K			
3	75 K			
4	100 K			
Area plot mq	6	(2 m x 3 m)		
Sowing	species	wheat (variety with possible sowing in winter and spring)		
	variety	ILLICO	seeding : 190 Kg/ha	
	n. of seeds/ha	3.500.000		
	distance of seed in the line			
	distance between the lines	15 cm		
	weight of 1000 seed	42,3 g		
soil/substrate		Landlab soil + 25% of Silica sand		
soil analysis attached		ric_svi_analisi suoli 2011		
starting date	14.11.13			
date of germination	03.12.13			

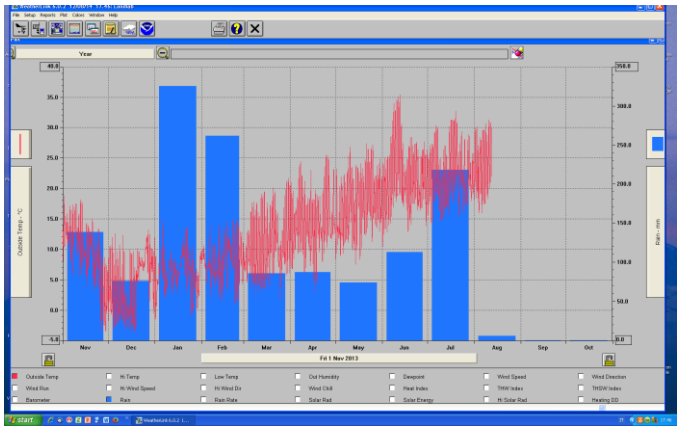
date	**kind of assessment**
25.1.14	evaluation of emergence
15.2.14	III° true leaf
1.03.14	start of tillering
11.3.14	start of vertical growth
8.4.14	2° node
21.4.14	flag leaf
29.4.14	start of earing
13.5.14	flowering
23.6.14	harvest

date	**treatment ***	**product**	**Kg/ha product**	**Kg/ha N**
14.11.13	application of base dressing N-K fertilizers	ammonium nitrate (30 unit of N)		
7.03.14	first PN foliar application	10Kg / 400 l		1,25 kg PN / 50 L
10.03.14	I° N application	urea (60 Unit of N)		
27.03.15	II° N application	urea (60 Unit of N)		
28.03.14	second PN foliar application	10Kg / 400 l		1,25 kg PN / 50 L

no phytotoxicity after the first and second foliar treatment

Weather conditions

The trial has been established in the last available "sowing window" of the year 2013.
After the trial start, a consistent serie of rain event has been recorded (LANDLAB Meteo Station DAVIS PRO).
The chart below shows the weather conditions during the trial. Winter has not been strong as usual with few nights below 0°C: it could be defined as a "very mild winter". Rain has been consistent (≈ 1.200 mm of rain during the trial) and frequent, leading to severe difficulties in running the trial operations, being the soils often in saturation conditions.



Despite the unusual winter and the extremely high rainfall the harvest has happen at normal time and a yield above the expected, has been achieved. Very probably the climate conditions have had a key role in achieving a "good" yield, in the "untreated" plots as well, by keeping a constant availability of the nutrients in the soil solution and an high organic matter mineralization.

Data analysis

The comment of the data starts from the observations:
plants height and **SPAD meter** measurements.

The height has been measured two times and at both times (see the chart below) there are no significant differences between the entries.

A light trend could be observed with the PN entry, as main effect, ending with 2 cm more than the untreated.

ANOVA one way: additive (yes/no)
Test Duncan, alfa 0,05

	height (cm)	
additive	**at 05.02**	
PN	61,7	a
-	62,0	a

	at 06.23	
-	67,9	a
PN	69,7	a

SPAD values, as index of the nutritional status of the plants, have been measured three times and the PN treatment, over all the K levels, shows (one way ANOVA on the left), at the second and third assessment, a significant difference from the untreated: elow on April the 29th and above on May the 15th.
Therefore the two way ANOVA has been conducted to look more in detail.

ANOVA one way, Duncan test
alfa 0,05
additive no/yes (PN)

additive	SPAD values	
	at 04.07	
PN	42	a
-	42	a
	at 04.29	
PN	48	a
-	51	b
	at 05.15	
-	45	a
PN	47	b

The SPAD values did not show large variations, probably due to the high N availability however, as shown in the chart on the right, on May the 15th, the entries treated with PN have superior SPAD values, with limited internal variation and only the "100 KCl + PN" entry being statistical different from "50 KCl no PN" one.

ANOVA two-way, Duncan test
alfa 0,05

K level	additive	at 05.15	
50	-	44	a
0	-	44	ab
75	-	44	ab
0	PN	46	ab
100	-	46	ab
75	PN	46	ab
50	PN	47	ab
100	PN	48	b

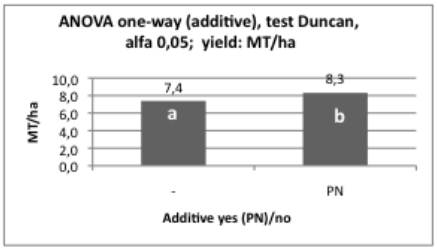
Yield data

The crop has been harvest on June the 23rd, about 5-7 days before the conventional harvesting date of the area. The **average yield of the trial is 7,85 MT/ha**, almost 1,0 MT above the expected one, and in line with potential of the area.

The **K level** does not show any statistical impact of the K being the production strongly driven by the PN application.

In fact, the analysis of the **"main effect application of the additive PN "** shows (chart on the left below) a clear and significant higher yield for the entries treated two times with 10 kg/ha of PN (8,3 MT/ha) vs the untreated entries (7,4 MT/ha).

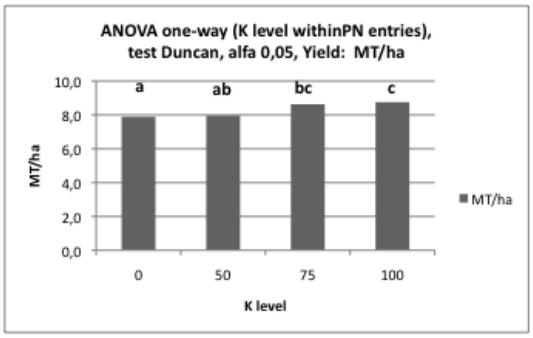
The two-way ANOVA (K level x yes/no additive), on the right, confirms the strong result with a very high confidence (alfa 0,001): the **100 KCl+ PN** is significantly different from **100 KCl no PN**, with, respectively, 8,8 MT/ha vs 7,5 MT/ha. It is also clearly visible that the PN application had a positive impact on any K level, leading to an yield increase of 0,7 – 1,3 MT.



Two-way ANOVA, test Duncan
alfa 0,001

K level	additive	MT/ha	
0	-	7,2	a
50	-	7,4	a
75	-	7,5	ab
100	-	7,5	ab
0	PN	7,9	abc
50	PN	8,0	abc
75	PN	8,6	bc
100	PN	8,8	c

Therefore analyzing the yield data, without the “disturbance” of the “untreated entries”, it can be observed that, within the **PN treated entries**, the K level has an impact with the K100 significantly higher in yield (8,8) of the K0 (7,9) and the K50 (8,0) but not diferent from the K75 (8,6).



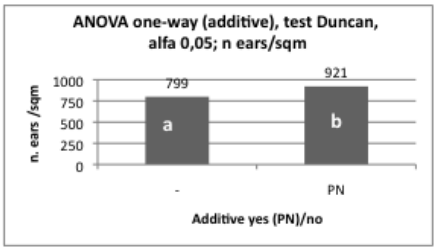
Other factors analyzed do not show any relevance therefore are not able to explain the differences:

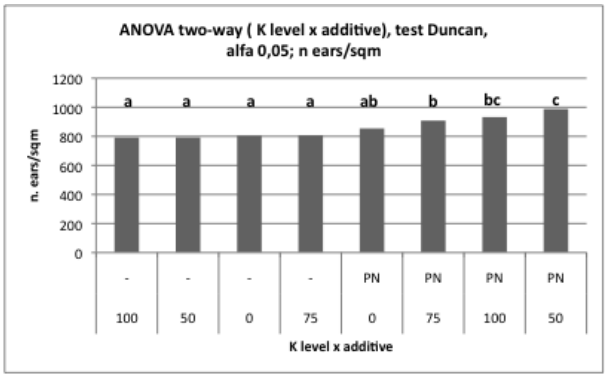
Humidity
13,68% PN treated
13,85 % untreated

1.000 seeds weight
g 30,6 PN treated
g 30,3 untreated

A factor with a key impact on the yield seems to be the “n. of ears”.

Similarly to the yield data the **number of ears** counted in the **PN treated** entries is significantly higher than the number of ears of the **untreated** ones with respectively **921 ears/sqm** and **799 ears/sqm.**





And also for this factor the PN treated entries are (see the chart on the right) in all cases superior as a trend, to the untreated ones which seem not be influenced by the K level.

Within the PN treated entries the ranking is not in the same order of the yield factor however, the K0 entry is at the bottom and significantly below the K50.
But a significant correlation between n. of ears and yield has not be founded, leading to the conclusion that other factors are involved in the yield differences.

entry	total protein	
0%KCl_PN	8,55	****
0%KCl	8,63	****
100%KCl_PN	8,64	****
75%KCl	8,66	****
50%KCl	8,67	****
100%KCl	8,68	****
75%KCl_PN	8,72	****
50%KCl_PN	8,74	****

The analysis of the protein in the grains does not show any significant difference however, the entries with no application of K at base dressing are at the bottom of the ranking. But the difference between the bottom and the top entry in protein content is very low (0,2 %) thus not allowing to conclude that there is a kind of trend.

Conclusions

The PN foliar applied in March was neither harming nor damaging the plants tissues.

The yield results are clear and statistically strongly supported even with a very high level of confidence: the application of PN is promoting an higher yield compared to the untreated entries and the K foliar applied is efficient over any level of base dressing K.

The effect generated by the PN application in March, could be linked with an extra quantity of nutrients - N and/or K - (nutritional effect) or as consequence of a hormon-like signal (biostimulant effect) coming from the low quantity of nutrients.

The application of Potassium Nitrate two times with the total quantity of 20 kg/ha is supplying to the plants 2,6 kg/ha of N as Nitrate, and 9,2 kg/ha of K_2O.

The K quantity, due to the high intake efficiency when foliar applied, could be seen as an extra K available (10 kg/ha over 96 kg/ha for the 100%K, 10 over 72 kg/ha for the 75%, 10 over 48 kg/ha for the 50% and 10 over 0 kg/ha).

Looking to the “untreated entries” it seems that the K is efficient already at 48 kg/ha and that the highest K levels do not generate any extra yield.

It may be that, due to the high rainfall some K at soil level has been leached, therefore giving to the K foliar applied a consistent nutritional value.

In fact ears are initiated during the Foundation Phase and spikelet initiation is completed as stem extension starts. Floret initiation and development then proceed until flowering: the number of potentially fertile florets depends on assimilate supplies to the ears, particularly during booting.

The N applied with the PN is surely not bringing any significant extra N: 2,6 kg/ha of N over a level of 140 kg/ha and in this case the leaching effect has not to be considered as N was applied in two events in March, after the heavy winter rain events.

However the N should be differently seen as Nitrate which hormone-like signalling role is well known, particularly when readily available.

The study is confirming the role of PN foliar applied in key moment of the crop cycle, at low dosage over different K base dressing nutrition.

Further investigations with deeper analysis and different trial design (soil fertility, water management, growth stage of the application) could eventually better explain the role of this product in enhancing the plants expression helping in understanding if what is often seen is mainly a nutritional effect and/or a biostimulant one and how those effects can be modulated by playing with the level of the product and the timing of the application.