Foliar sprays with potassium nitrate increase rice yields

Four field trials performed in Vietnam during the spring and summer of 2009 showed that rice growers can significantly increase their yields and enjoy higher income by enriching crop nutrition with one or more foliar application of potassium nitrate.
Foliar application of potassium nitrate increased yields by 15%. Farmers' net income was increased by 13%.

Introduction

With 156 million hectares of rice fields, this crop is one of the world's major cereal crops, second to wheat only. More than 80% of the world's rice is grown in Asia, where it provides basic nutrition and food security to poor populations.

Rice crops remove considerable amounts of potassium from the soil, and yields are highly dependent on potassium fertilization. Introduction of high-yielding rice varieties enables more efficient production, but to gain the full benefits of these varieties, adequate supply of nutrients, and particularly potassium, is required.

In order to study the effect of potassium nitrate sprays on rice yieds, PNA[1] has conducted a trial in Vietnam during 2009. The trail was carried out by Dr. C. Witt, Director of IPNI South East Asia program, and Dr. Thuc Son from SFRI, Hanoi.

Materials and methods

Four trials were conducted on a spring and summer rice crop, grown on 2 locations (Tables 1, 2 and 3). Trials were laid out in a randomized complete block design with 4 replicates. Plot size was 24 m² (4.6x5.2 m).

Potassium nitrate was sprayed at one or more different growth stages: Active Tillering (AT), Panicle Initiation (PI) and End of Flowering (EF), at 3% concentration, equal to 9 kg KNO_3/ha/spray (Table 4).

Table 1. Varieties and planting density per trial

Location	Soil quality	Season	Rice variety	Spacing (cm^2)	Density (hills/m^2)
Nam Dinh	Degraded soil	Spring	Hybrid Juu 527 (China)	25x13	31
		Summer	TH3-3 (Vietnam)	25x13	31
Bac Giang	Alluvial soil	Spring	Inbred Khang Dan 18	20x10	50
		Summer	Inbred Khang Dan 18	20x10	50

Table 2. Description of the experimental sites in Nam Dinh and Bac Giang.

Parameter	Nam Dinh site	Bac Giang site
Soil type	Alluvial, heavy soil	Degraded, sandy soil
Extractable K	0.15 cmol/kg	0.08 cmol/kg
Organic carbon	13.5 g/kg	8.6 g/kg
CEC	15 meq/100g	4-5 meq/100g
pH	5.5-6	5.5

[1] PNA is a non-profit association of potassium nitrate producers

Haifa Chemicals Ltd. P.O.Box 10809, Haifa Bay, Israel
Tel: +972-4-8469616, Fax: +972-4-8469953, E-mail: info@haifachem.com
www.haifachem.com

Table 3. Soil fertilization: nutrients sources, timing of application and rates

Source	Timing of application	Unit	Spring rice		Summer rice	
			Nam Dinh	Bac Giang	Nam Dinh	Bac Giang
Farmyard manure	Basal	MT/ha	8	8	8	8
Urea 46% N	10-15 DAT	Kg/ha	40	30	30	20
	25 DAT (AT)	Kg/ha	40	30	40	30
	50-55-DAT (PI)	Kg/ha	40	30	30	30
	Total	Kg/ha	120	90	100	80
SSP 16% P_2O_5	Basal	Kg/ha	70	60	60	45
KCl 60% K_2O	Basal	Kg/ha	90	70	90	70

DAT – days after transplanting; AT – active tillering; PI – panicle initiation

Table 4. Foliar potassium nitrate treatments

No	Soil fertilization	Addition spraying KNO_3*		
		AT	PI	EF
1	NP	0	0	0
2	NP	+	+	+
3	NPK (Basal 100%.MOP)	0	0	0
4	NPK (Basal 100%.MOP)	+	0	0
5	NPK (Basal 100%.MOP)	0	+	0
6	NPK (Basal 100%.MOP)	0	0	+
7	NPK (Basal 100%.MOP)	+	+	0
8	NPK (Basal 100%.MOP)	0	+	+
9	NPK (Basal 100%.MOP)	+	+	+
10	NPK (Basal 75%.MOP)	+	+	+
11	NPK (Basal 50%.MOP)	+	+	+
12	NPK (Basal 50%+50%.at PI)	0	0	0

*Concentration of KNO_3 3% with 300 liter/ha

AT – active tillering; PI – panicle initiation; EF – end of flowering

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Results and discussion

Yield results

Table 5 shows rice grain yields obtained in the two trials. All plots receiving foliar sprays produced statistically significant (P < 0,05) higher yields than the non-sprayed control plot (T3). Three foliar sprays (T9) resulted in yield increase of 15%. Two sprays (T7 and 8) and single spray application (T4, 5 and 6) increased grain yields by average of 11% and 7%, respectively. Interestingly enough, T11 shows that 10% yield increase, compared to the control T3, was achieved with 3 foliar applications of potassium nitrate, while KCl base dressing was reduced by 50%.

Table 5. Rice grain yields as affected by fertilization treatment

Treatment	Spring 2009				Summer 2009				Grand total	
	Nam Dinh		Bac Giang		Nam Dinh		Bac Giang		Average (%)	
	MT/ha	%	MT/ha	%	MT/ha	%	MT/ha	%		
1*	6.69	92	4.89	88	4.62	93	3.85	85	90	
2	7.80	107	5.59	101	5.38	109	4.47	99	104	
3	7.30	100	5.53	100	4.95	100	4.52	100	100	
4	7.84	107	5.78	105	5.29	107	4.90	108	107	107
5	8.02	110	5.79	105	5.41	109	4.89	108	108	
6	7.87	108	5.83	105	5.36	108	4.83	107	107	
7	8.16	112	5.86	106	5.48	111	5.13	113	110	111
8	8.18	112	5.94	107	5.50	111	5.14	114	111	
9	8.49	116	6.16	111	5.67	115	5.26	116	115	115
10	8.33	114	6.12	111	5.43	110	5.13	113	112	
11	8.15	112	6.06	110	5.41	109	5.02	111	110	
12	7.97	109	5.74	104	5.21	105	4.78	106	106	
LSD (P=0.05)	0.576		0.14		0.324		0.11			

* Average of NP with and without farmyard manure

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Economical analysis

Table 6 shows net income obtained from the various treatments. All plots receiving foliar sprays increased grower's net income by statistically significant ($P < 0,05$) rates, compared to the non-sprayed control plot (T3). Three foliar sprays (T9) resulted in increased net income by 13%. Two sprays (T7 and 8) and single spray application (T4, 5 and 6) increased net income by average of 10% and 7%, respectively.

Three foliar application with reduction of KCl base-dressing by 25% and 50% (T10 and T11) increased net income by 12%.

Table 6. The effect of foliar sprays with potassium nitrate on grower's benefit

Treatment	Spring 2009				Summer 2009				Grand total	
	Nam Dinh		Bac Giang		Nam Dinh		Bac Giang		Average (%)	
	US$/ha	%	US$/ha	%	US$/ha	%	US$/ha	%		
1*	1441	99	1165	94	953	105	903	92	97	
2	1650	113	1291	104	1075	119	1007	102	109	
3	1463	100	1239	100	905	100	986	100	100	
4	1576	108	1286	104	967	107	1069	108	107	107
5	1621	111	1289	104	997	110	1066	108	108	
6	1583	108	1300	105	985	109	1049	106	107	
7	1633	112	1285	104	992	110	1110	113	109	110
8	1638	112	1308	106	997	110	1113	113	110	
9	1692	116	1346	109	1017	112	1123	114	113	113
10	1684	115	1359	110	988	109	1111	113	112	
11	1670	114	1367	110	1014	112	1105	112	112	
12	1625	111	1292	104	965	107	1053	107	107	

* Average of NP with and without farmyard manure

Price of potassium nitrate: 1300US$/ton.

Price of rice grains: 278 US$/ton grains of Kang dan variety (Bac Giang trial); 250 US$/ton grains of hybrid rice (Nam Dinh trial).

1 US$=18000 VND

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