AB-16

EFFECT OF THE SEEDROW PLACED COATED KCl ON SEED GERMINATION AND SEEDLING GROWTH

(1996 annual report on coated KCl project)

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BACKGROUND

Primarily there are two objectives of developing controlled-release fertilizers: synchronizing the nutrient release with plant demand to increase efficiency, and lowering the risk of fertilizer contamination to the environment. Recently more attention has been paid to the seedrow fertilizer placement due to the increase of direct seeding. Because the soluble nutrients are 'wrapped' by polymers in controlled-release fertilizers, the controlled-release fertilizers, therefore, are considered as the good sources of fertilizers to be placed in the seedrow. The release rate of controlled release fertilizers is affected by temperature and coating thickness (Christianson, 1988, Kochba et al., 1990, Zhang, 1994).

In the research proposal of 'Agronomic Aspect of Coated Potassium Chloride' submitted on September, 1996, we planned three experiments: seedrow placement of coated KCl; application of coated KCl on irrigated turfgrass; and rice production on red soil fertilized with coated KCl. Upon the submission of the proposal, we managed to take undisturbed soil column with Bentgrass and Kentucky bluegrass for the irrigated turf experiment, and arranged to get acidic red soil samples from Brazil and China. Because of the season, we were unable to get the undisturbed soil column. The acid red soil

samples, after more than half a year preparation and transportation, will be available in the late June of 1997. But we have finished seedrow coated KCl placement trials. Also we have partly completed KCl uptake, and effect of coated KCl on plant physiological leaf spot experiments. The main subject of this annual report was on seedrow placement of non-coated and coated KCl.

The objective of the seedrow KCl placement was to determine the rate of K application and the coating thickness on the germination and seedling growth of barley, wheat and canola.

METHODS AND MATERIALS

We have conducted two experiments in the greenhouse. There were three sources of KCl, *i.e.* non-coated KCl, thinly coated KCl (Coated I), and thickly coated KCl (Coated II). The soil used in the both experiments was Black Cherozem (pH: 7.5, organic matter content: 8.5, field capacity (F.C.): 32.6%). Three crops, barley (Harrington and Duke cultivars), wheat (Cutler cultivar) and canola (Legacy cultivar) were used in the experiments. Harrington and Duke barley were used in the first and second experiment, respectively. There were 3 replicates for each of the experiments. Both experiments were conducted for 21 days. In day 21 after seedling, shoots were harvested and dried at 65°C and then weighed.

In the first experiment, the rate of K application was 20, 40 and 80 kg K/ha. Eight seeds were placed in potted soil about 0.5 cm apart in a row in a depth of 1 cm. KCl granules were placed between two seeds. The potted soil was kept in 90% F.C. during

21-day plant growing period. Shoot height was measured in the first and second week after seeding.

In the second experiment, the rate of K application was 40, 80 and 160 kg K/ha. Like the first experiment, 8 seeds were placed in potted soil about 0.5 cm apart in a row in a depth of 1 cm, but the KCl granules were placed side by side with the seeds. The potted soil was kept in 70% F.C.. In the 4th day after seeding, germinated seeds per pot was counted. The shoot height was measured in each week after seeding.

RESULTS AND DISCUSSION

First Experiment (90% F.C. of soil water content)

The rate of KCl application and coating had a limited affect on seed germination for all three crops (Table 1). However, shoot height was found lower with the 80 kg K/ha of non-coated KCl than with 20 or 40 kg K/ha of non-coated KCl in all three crops (Table 1). Shoot height from Coated I and II treatments was higher than that from non-coated KCl at a rate of 80 kg K/ha for canola, but not for wheat and barley. The dry mass production in the 3rd week after seeding, was varied between the non-coated KCl and coated KCl treatments, or among the different K rate application for canola and wheat (Table 2). Nevertheless, barley dry mass at 80 kg K/ha of non-coated KCl was lower than that of 20 and 40 kg K/ha of non-coated KCl, but similar to that of coated KCl (Coated I and Coated II).

In all, it appeared that coating protected seedling from salt injury of KCl. However, with the application rate 20, 40 and 80 kg K/ha, the difference among the

treatments was not as great as we might expect. Also dilution of KCl under the high soil water content (90% F.C.) did reduce the negative impact of KCl on seed germination. In addition, placing KCl granules between seeds probably reduced KCl effect on seed germination because there was no direct contact of seeds with KCl fertilizers.

Second Experiment (70% F.C. of soil water content)

In four days after seeding, no seeds were germinated in 80 and 160 kg K/ha of non-coated KCl in all three crops (Table 3). But at the same time, seeds were germinated in 80 and 160 kg K/ha of coated KCl treatments in the three crops. Notably, Coated II had more seeds germinated than Coated I. Increasing coating thickness reduced KCl damage to seed germination.

In the first week after seeding, 88 and 50% of barley seeds and 88 and 63% of wheat seeds germinated at the 80 and 160 kg K/ha of non-coated KCl, respectively. Canola seeds, on the other hand, had only 63% germination at 80 kg K/ha, but none at 160 kg K/ha of the non-coated KCl. The shoot height of all three crops was reduced by high dose of non-coated KCl application (Table 4). Coated I stunted barley and wheat growth at 80 and 160 kg K/ha, respectively, but not canola. Coated II had negative impact on plant growth only at 160 kg K/ha in all three crops. Even coated KCl decreased plant growth in a certain degree, they still generated better shoot growth in comparison with the non-coated KCl in any K application rate.

In the second and third week after seeding, the differences in shoot height among the treatments showed a similar pattern as that in the first week (Table 4). After growing

for three weeks, it was showed that increasing the rate of non-coated KCl application reduced dry mass production in all three crops, in contrast, raising the application of the coated KCl had a limited influence (i.e. Coated I) or no influence (i.e. Coated II) on dry mass production for all three crops (Table 5). Further more, coated KCl (Coated I and Coated II) produced significantly higher yield than non-coated KCl at 80 and 160 kg K/ha in any of the crops. Coating, in fact, prevents the seed germination and seedling growth from the injury of seedrow placed KCl.

Unlike the first experiment, the results of the second experiment clearly indicate that coated KCl had less negative impact on the seed germination and seedling development. The results also suggest that a certain coating thickness is required in order to protect seed germination and seedling development from the injury of seedrow placed KCl. Compared to the first experiment, the results show that the advantage of applying coated KCl in seedrow is more prominent when the soil water content is low.

Our results have showed the merit of the coated KCl placed on the seedrow. But a field experiment is needed for verification of the results from the greenhouse. Also further research is required on developing a cheap coating material, on which lies the future of the coated KCl. In summary, coating conventional KCl granules is an effective mean to minimize the germination injury from seedrow placed KCl. A certain thickness of coating is also required in order to secure the advantage of the coating.

We plan to do another seedrow KCl placement experiment with 50% F.C. of soil water content in the greenhouse. With such soil water content, the advantage of using coated KCl in seedrow will be more obvious.

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Table 1. Shoot height and percent seeds germinated in the first seedrow KCl placement experiment

Crops	Sources of KCl	1st week Rate of K (kg K/ha)					2nd week Rate of K (kg k/ha)				
		Nil	20	40	80	LSD 0.05	Nil	20	40	80	LSD 0.05
		..... cm									
Canola											
	Non coated	3.4(38)[1]	3.7(75)	3.2(75)	1.5(88)	0.1	7.9(50)	8.2(88)	7.1(75)	5.7(88)	0.4
	Coated I	3.4(38)	3.5(88)	3.5(88)	4.1(63)	0.1	7.9(50)	6.9(88)	7.1(88)	7.8(88)	0.4
	Coated II	3.4(38)	3.9(88)	3.3(88)	3.1(100)	0.2	7.9(50)	7.5(88)	7.6(88)	7.4(100)	0.2
	LSD 0.05		0.1	0.2	0.1			0.2	0.1	0.1	
Barley											
	Non coated	10.6(88)	9.8(63)	9.2(88)	7.6(75)	0.2	25.3(88)	24.8(63)	25.2(88)	22.7(63)	0.3
	Coated I	10.6(88)	7.4(63)	8.2(88)	7.5(63)	0.2	25.3(88)	24.2(63)	23.7(88)	21.9(88)	0.4
	Coated II	10.6(88)	9.3(63)	8.6(75)	7.8(50)	0.1	25.3(88)	24.0(75)	23.4(75)	23.1(88)	0.9
	LSD 0.05		0.2	0.1	0.1			0.3	0.6	1.1	
Wheat											
	Non coated	11.8(100)	11.3(88)	11.0(100)	10.3(100)	0.2	26.0(100)	25.4(88)	25.3(100)	26.4(100)	0.5
	Coated I	11.8(100)	11.1(100)	11.3(100)	10.0(100)	0.2	26.0(100)	25.8(100)	25.8(100)	26.9(100)	0.3
	Coated II	11.8(100)	11.5(100)	10.2(100)	10.1(100)	0.2	26.0(100)	26.5(100)	26.5(100)	24.9(100)	0.1
	LSD 0.05		0.1	0.1	0.1			0.3	0.1	0.1	

[1]Numbers in parenthesis are the percent seeds germinated.

Table 2. Dry mass production in the first seedrow KCl placement experiment

Crops	Sources of KCl	Rate of K (kg k/ha) Nil	20	40	80	LSD 0.05
			g			
Canola						
	Non coated	0.72	1.16	0.99	1.00	0.01
	Coated I	0.72	1.12	1.16	0.98	0.02
	Coated II	0.72	1.07	1.02	1.08	0.01
	$LSD_{0.05}$		0.01	0.01	0.01	
Barley						
	Non coated	1.07	0.95	1.06	0.83	0.02
	Coated I	1.07	0.83	0.96	0.86	0.01
	Coated II	1.07	0.97	0.90	0.82	0.02
	$LSD_{0.05}$		0.01	0.01	0.02	
Wheat						
	Non coated	1.19	1.04	1.01	1.08	0.01
	Coated I	1.19	0.89	1.12	0.86	0.01
	Coated II	1.19	0.88	0.89	0.92	0.01
	$LSD_{0.05}$		0.01	0.01	0.01	

Table 3. Percent seeds germinated in the second seedrow KCl placement experiment

Crops	Sources of KCl	4th day Rate of K (kg K/ha)				1st week Rate of K (kg k/ha)				2nd week Rate of K (kg K/ha)				3rd week Rate of K (kg K/ha)			
		Nil	40	80	160	Nil	40	80	160	Nil	40	80	160	Nil	40	80	160
		..... %															
Canola																	
	Non coated	88	38	0	0	100	88	63	0	100	88	75	38	100	88	75	50
	Coated I	88	88	63	25	100	88	88	50	100	100	100	50	100	100	100	50
	Coated II	88	88	88	63	100	88	100	88	100	100	100	88	100	100	100	88
Barley																	
	Non coated	100	13	0	0	100	100	88	50	100	100	100	88	100	100	100	88
	Coated I	100	100	75	38	100	100	100	88	100	100	100	100	100	100	100	100
	Coated II	100	88	50	50	100	100	100	88	100	88	100	88	100	88	100	88
Wheat																	
	Non coated	88	75	0	0	100	100	88	63	100	88	100	100	100	88	100	100
	Coated I	88	88	50	25	100	100	100	88	100	100	100	100	100	100	100	100
	Coated II	88	88	100	50	100	100	100	75	100	100	100	75	100	100	100	75

[1]Numbers in parenthesis are the percent seeds germinated.

Table 4. Shoot height in the second seedrow KCl placement experiment

Crops	Sources of KCl	1st week Rate of K (kg K/ha)					2nd week Rate of K (kg k/ha)					3rd week Rate of K (kg K/ha)				
		Nil	40	80	160	LSD 0.05	Nil	40	80	160	LSD 0.05	Nil	40	80	160	LSD 0.05
		..... cm														
Canola																
	Non coated	5.0	2.0	1.5	0.0	0.1	6.8	4.4	3.7	2.7	0.1	12.3	9.9	9.1	5.8	0.2
	Coated I	5.0	4.3	3.0	3.6	0.6	6.8	6.1	4.9	4.9	0.3	12.3	12.1	10.0	10.4	0.5
	Coated II	5.0	4.5	5.0	3.9	0.1	6.8	6.1	6.4	5.7	0.1	12.3	11.1	12.5	11.5	0.1
	LSD 0.05		0.2	0.1	0.3			0.1	0.1	0.2			0.2	0.3	0.4	
Barley																
	Non coated	11.3	8.1	5.5	2.9	0.3	21.4	19.9	18.1	15.1	0.8	28.6	30.2	29.2	27.9	1.1
	Coated I	11.3	11.4	9.4	7.7	0.4	21.4	22.4	19.1	20.5	1.1	28.6	30.0	27.7	29.5	1.0
	Coated II	11.3	9.7	9.4	8.4	0.2	21.4	19.8	20.4	21.5	0.6	28.6	29.1	30.9	30.7	1.7
	LSD 0.05		0.2	0.3	0.3			0.5	1.4	0.6			1.3	1.0	0.9	
Wheat																
	Non coated	11.4	10.0	3.9	2.5	0.3	22.9	24.2	19.4	16.2	2.5	25.1	27.3	24.6	21.8	3.8
	Coated I	11.4	12.0	9.7	7.8	0.1	22.9	25.3	23.7	20.9	0.7	25.1	28.0	27.8	26.0	0.9
	Coated II	11.4	11.4	11.0	9.6	0.4	22.9	25.1	23.6	22.6	1.4	25.1	29.0	26.1	27.0	1.4
	LSD 0.05		0.1	0.4	0.3			0.8	0.5	1.7			1.3	1.3	2.5	

Table 5. Dry mass production in the second seedrow KCl placement experiment

Crops	Sources of KCl	Rate of K (kg k/ha) Nil	40	80	160	LSD 0.05
			g			
Canola						
	Non coated	0.69	0.61	0.47	0.12	0.01
	Coated I	0.69	0.64	0.58	0.48	0.01
	Coated II	0.69	0.72	0.84	0.77	0.01
	LSD 0.05		0.01	0.01	0.01	
Barley						
	Non coated	0.99	1.01	0.94	0.69	0.01
	Coated I	0.99	1.07	0.98	1.04	0.01
	Coated II	0.99	0.92	1.19	1.18	0.01
	LSD 0.05		0.01	0.01	0.01	
Wheat						
	Non coated	0.74	0.92	0.65	0.54	0.02
	Coated I	0.74	0.92	0.88	0.84	0.01
	Coated II	0.74	1.17	0.86	0.79	0.01
	LSD 0.05		0.01	0.01	0.01	