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Waterlogging effects on nodulation and nitrogen fixation of supernodulating soybeans

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Objectives

To evaluate the changes of nodulation and nitrogen fixation of supernodulating soybeans under flooded condition at flowering period.

Materials and Methods

Two supernodulating soybean genotypes, SS2-2 and Sakukei 4, and two normal genotypes, Sinpaldalkong 2 and Enrei, were used. The experiment were carried out in open flooding treatment facility under natural light at the National Agriculture Research Center in Tsukuba Japan. Five seeds per pot were sown on June 16, 2005 in a plastic pot, which was 15.9cm in diameter and 19cm in height. Pots were filled with volcanic ash soil. Fertilizer was not applied. The pot were divided into two groups at the 33 days after sowing(DAS). One group was continuously flooded at 3~4cm above the soil surface for 15 days and the other was normally irrigated. Three seedlings for each treatment were sampled to measure nodule number, leaf spad value, shoot N content, xylem sap at four times: just before flooding initiation(33DAS), just after 15 days flooding treatment(48DAS), 41 days after flooding finishing(89DAS). Collection and analysis of xylem bleeding sap was conducted using the procedure of Simamura et al.(2002). Concentrations of amino-N, nitrate-N, and ureide-N in the xylem sap were determined using the ninhydrin technique (Herridge, 1984), the salicylic acid technique(Cataldo et al., 1975), and the method of Young and Conway (1942), respectively.

Result and Discussion

By the excessive water stress, nodule numbers and weight of supernodulating soybeans were higher than that of normal genotypes, and single nodule weight tend to increase during recovery period after finishing the water stress, and increase width of normal genotypes were particularly high. Shoot dry weight were high in supernodulating soybeans under the control treatment and in normal genotypes under the excessive water treatment. Spad value maintained a tendency to increase slowly in all genotypes under the control treatment and to increase slowly after keep or decrease under the excessive water stress.

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Tabel 1. Nodule number and nodule dry weight per plant

Water treatment	Variety	Nodule no. (no./plant)			Nodule dry weight (g/plant)		
		33 DAS	48 DAS	89 DAS	33 DAS	48 DAS	89 DAS
WW	Sakukei 4	553.3	682.7	1027.7	0.28	0.73	1.48
	SS2-2	481.3	549.0	935.0	0.24	0.75	1.55
	Enrei	59.7	125.3	269.7	0.06	0.21	0.74
	Sinpaldalkong 2	64.3	144.3	284.0	0.08	0.23	0.69
EW	Sakukei 4	553.3	221.0	99.3	0.28	0.21	0.33
	SS2-2	481.3	147.3	50.7	0.24	0.15	0.15
	Enrei	59.7	50.7	69.7	0.06	0.09	0.41
	Sinpaldalkong 2	64.3	50.7	32.0	0.08	0.13	0.21

* WW : Well Water, EW : Excessive Water
* DAS : Days after sowing

Tabel 2. Concentrations of ureide-N, α-amino-N, and nitrate-N in the xylem bleeding sap collection from soybean plants.

Time of sampling	Water treatment	Variety	Ureide-N (μ mol/ml)	α-amino-N (μ mol/ml)	Nitrate-N (μ mol/ml)
33 DAS	WW	Sakukei 4	18.78	3.14	0.70
		SS2-2	28.25	1.69	0.20
		Enrei	6.88	6.70	1.65
		Sinpaldalkong 2	10.20	2.97	0.38
48 DAS	WW	Sakukei 4	23.96	1.01	0.13
		SS2-2	25.65	1.21	0.12
		Enrei	17.86	1.06	0.08
		Sinpaldalkong 2	15.60	0.86	0.10
	EW	Sakukei 4	4.06	2.55	0.13
		SS2-2	4.43	3.80	0.23
		Enrei	8.02	2.92	0.14
		Sinpaldalkong 2	6.87	0.63	0.17
89 DAS	WW	Sakukei 4	24.67	2.85	0.11
		SS2-2	20.20	3.53	0.10
		Enrei	32.58	3.99	0.19
		Sinpaldalkong 2	28.59	3.54	0.21
	EW	Sakukei 4	23.84	3.21	0.43
		SS2-2	7.04	2.59	0.81
		Enrei	23.00	4.39	0.17
		Sinpaldalkong 2	10.36	2.28	0.36