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Effects of Nitrogen Sources on RNA, DNA and other Phosphorus Fractions of Soybean Cultivars Different in Phosphorus Sensitivity

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燐酸感受性이 다른 大豆品種의 RNA, DNA 및 기타 燐酸形態에 對한 窒素源의 影響에 관한 硏究

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SUMMARY

RNA, DNA and other phosphorus fractions were determined in the leaf and root of soybean plants different in phosphorus sensitivity grown in NH_4-N, NO_3-N and urea medium.

The phosphorus sensitive cultivars contained higher ASIP (acid soluble inorganic phosphorus) than the tolerant cultivars with all nitrogen sources.

ASIP was highest in the urea treated plants and lowest in the nitrate treated plants. Total phosphorus content was mostly affected with increase in ASIP. When ASIP increased, acid solsuble organic phosphorus(ASOP), phospholipids (L-P), RNA-P, residual phosphorus (R-P) tended to increase, while DNA-P showed little change. The percent RNA-P or DNA-P of total phosphorus in the nitrate treated plant was twice that in the ammonium treated plant, which were also higher in tolerant cultivars regardless of nitrogen sources. The percent ASOP in total acid soluble phosphorus (ASOP/ASP×100) decreased as phosphorus sensitivity decreased. Indications are that phosphorus sensitivity depends on the relative sizes of phosphorus metabolic pools.

Total dry matter yield was negatively correlated with total phosphorus ($r=0.84$ significant at 0.01P), ASIP (0.84 significant at 0.01P) and residual phosphorus (0.69 significant at 0.05P). ASOP showed positive correlation with L-P, RNA-P and DNA-P but negative with R-P. RNA-P was significanly correlated only with L-P (0.63 at P=0.

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01). There was significant interaction (0.01P) among nitrogen sources, cultivars and phosphorus metabolic pools.

Phosphorus sensitivity and ammonium toxicity appear to be same in view of energy metabolism, that is, the former inhibits the conversion of ATP to ADP (energy releasing) through phosphate potential while the latter inhibits ATP formation (energy storing).

INTRODUCTION

For the elucidation of phosphorus metabolism in phosphorus excess among soybean varieties Lee et at (8) investigated phosphorus fractions. Both acid-soluble phosphorus and phospholipids in soybean leaves were always higher in the susceptible variety than in the tolerant variety. It was concluded that susceptibility of Lincoln soybean to high phosphorus supply may be attributed to the decrease in the RNA content of leaf. One interesting and questionable point was the increase in RNA and DNA in the only tolerant variety while acid-soluble phosphorus and lipid-phosphorus decreased. This is not consistent with the result by Roux (16) in the relationship between phosphorus pools. The degree to which the various fractions were affected by phosphorus deficiency was in decreasing order, inorganic orthophosphate, phospholipids, phosphorylated acid soluble esters, RNA and DNA. The inorganic phosphorus fraction seems to be the major control pool. Above investigation was designed with single factor, phosphorus.

In previous papers the effects of nitrogen sources in relation to soybean phosphorus sensitivity were investigated on the growth (12, chlorophyll content and oxidative enzyme activity (13) and photosynthesis respiration equitibrium point and amino acid content (17). Those results indicated close relation of phosphorus sensitivity to other metabolism rather than phosphorus metabolism per se. Even study on phosphorus metabolism per se in relation to phosphorus sensitivity was very rare. Furthermore reports on phosphorus metabolism of phosphorus sensitive soybean plant in relation to nitrogen sources is hard to find out.

In this paper the change of phosphorus pools of soybean plant different in phosphorus sensitivity in relation to nitrogen sources was investigated and probable explanation on mechanism of phosphorus sensitivity was given.

MATERIALS AND METHODS

The six soybean selections grown in NH_4-N, NO_3-N and Urea-N culture solution (12) were used to the following investigation.

Phosphorus fractions: One gram fresh tissue or 0.2g lyophilized tissue from the 3rd trifoliate was used for determination of acid soluble inorganic phosphorus (ASIP), acid soluble organic phosphorus (ASOP), lipid phosphorus (L-P) RNA-P, DNA-P and residual phosphorus (R-P), based on previously reported methods (3, 8). Each phosphorus was summed for total phosphorus content. Flow chart of phosphorus fractions are as follow.

Phosphorus was determined by the modified Fiske-Subarrow method (2) after acid digestion (3). Analysis was single run per plant and plants per treatments were three replicates.

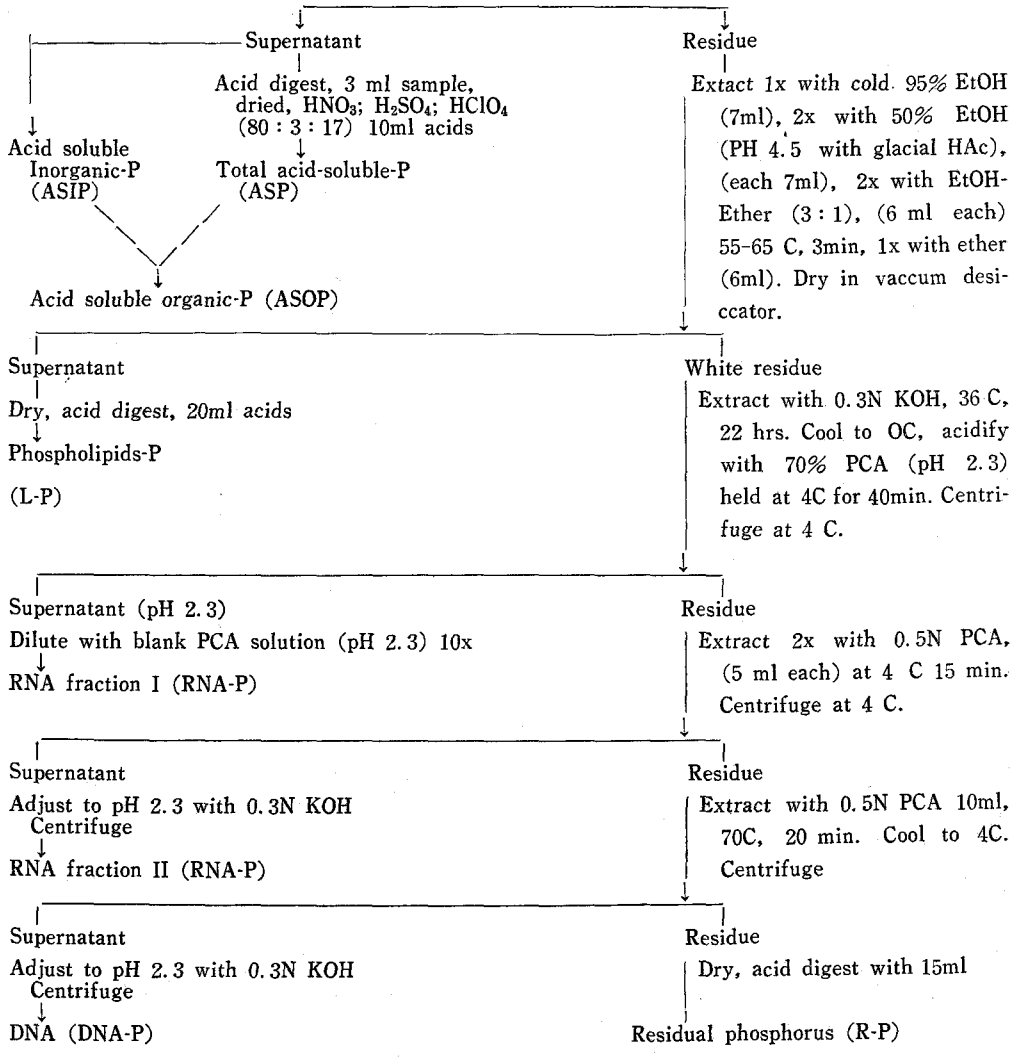
Acid digestion: Aliquots of sample solutions were dried in the oven and a mixture of concentrated nitric, perchloric and sulfuric acids (80 : 17 : 3) was added (10-15ml). Samples were digested on an electric hot plate until digests were clear and dense, white fumes were given off. They were then cooled and 2-3ml of deionized water and 2 drops of dinitrophenol indicator were added. NaOH (20%) was added dropwise until a yellow color persisted. The samples were back-titrated with 1N H_2SO_4 until the yellow color disappeared. Phosphorus was determined on the entire sample or on a suitable aliquot by the modified Fiske-Subarrow method (2).

Modified Fiske-Subarrow Method:

Acid molybdate solution: Add 136 ml of conc-

Flow chart for phosphorus fractionation.

Fresh soybean leaf tissue (1g) or liophylized (0.2g). Extract 2x with 0.2N PCA (20ml..×10ml.), 4C., 15 min. Centrifuge 8000×g., 10min.



entrated $H2SO_4$ to 360 ml deionized water and cool. Dissolve 25g ammonium molybdate in 500 ml deionized water. Add molybdate solution to sulfuric acid solution. Dilute to one liter.

Reducing agent: 15g of sodium bisulfite ($NaHSO_3$) and 5g of Elon (P-methylaminophenol) are dissolved in 500ml deionized water. Store at 4°C out of light. A fresh solution should be used after 10 days.

Color development: Add 3ml of sample solution (pH 6.5~7.5) in a 20ml test tube, then add 5 ml deionized water. Add 1 ml of acid molybdate solution and mix with the Vertex mixer. Add 1 ml of reducing agent and mix thoroughly. Measure the absorbance at 660 nm after 20 minutes.

RNA and DNA Determination: Samples for RNA and DNA estimation were adjusted to pH 2.2—2.3 before spectrophotometric determination. RNA-1 fraction was diluted ten fold. The ultraviolet absorbance curve was obtained by using Perkin-Elmer 202 spectrophotometer and the RNA was calculated from the difference of absorbance at 260 nm and at 295 nm using a standard curve derived from known quantities of yeast

RNA. DNA was calculated from the difference at 270 nm and 295 nm by comparison to a standard curve based on sperm DNA. Soybean leaf RNA showed maximum absorbance at 260 nm as did yeast RNA; similarly, soybean DNA absorbed maximally at 270 nm as did sperm DNA. Phosphorus content in the nucleic acids was calculated based on an assumed 10% phosphorus for RNA or DNA. The calculated phosphorus content of the RNA fractions were compared to that of the acid digestion method.

RESULTS

Various phosphorus fractions in soybean leaves are shown in Tables 1 and 2. The acid soluble phosphorus fraction (ASP) extracted with 0.2N perchloric acid includes the acid soluble inorganic phosphorus (ASIP) and acid soluble organic phosphorus (ASOP). ASIP includes inorganic orthophosphate and pyrophosphate. ASOP includes sugar phosphates, various free nucleotides, phosphoglyceric acid, thiamine phosphate and phosphoryl choline. The fractions soluble in lipid-solvents (alcohol and ether) consist of phosoholipids. All other remaining phosphorus as well as phosphoprotein, except RNA and DNA, are included in residual phosphorus fraction (R-P)(8). From seventy to over ninety percent of total phosphorus occurred as organic phosphorus. Except for high inorganic phosphorus the level of the other fractions were similar to results previously reported (8). Phosphorus fraction may be considered as metabolic phosphorus pools.

The relations between nitrogen source, variety and phosphorus metabolic pool in the leaves are shown in Table 3. The effect of nitrogen sources on total phosphorus was highly significant (0.01P). However, the varietal difference is less significant than in nitrogen source (0.05P). The interaction between nitrogen source and variety

Table 1. The Effect of Nitrogen Source on Different Phosphorus Fractions in the Soybean Leaves That Differ in Phosphorus Sensitivity.

		ASP	ASIP[1]	ASOP[2]	L-P	RNA-P[4]	DNA-P[4]	R-P	T-P[1]	ASIP/ASP ×100	AIP/ASOP
	Lee	5.79[3]	4.19[a]	1.60	0.75	1.70	0.19	0.16	8.58[a]	72.4	2.62
NO_3-N	R56-49	7.50	5.65[c]	1.85	0.52	1.41	0.16	0.16	9.75[a]	75.3	3.05
	Clark-63	8.46	7.29[b]	1.17	0.61	1.40	0.18	0.15	10.80[a]	86.2	6.23
	Mean	7.25	5.71	1.54	0.63	1.51	0.18	0.16	9.71	78.8	3.70
	Lee	13.00	11.20	1.80	0.86	1.87	0.19	0.15	16.04[b]	86.2	6.22
NH_4-N	R56-49	15.14	13.01[f]	2.13	0.98	1.85	0.19	0.19	18.35[c]	85.9	6.12
	Clark-63	20.86	19.48[e]	1.38	0.60	1.72	0.15	0.23	23.60[d]	93.4	14.12
	Mean	16.34	14.56	1.77	0.81	1.80	0.18	0.19	19.32	89.1	8.22
	Lee	13.04	11.32[d]	1.72	0.67	1.15	0.21	0.17	15.27[b]	86.8	6.58
Urea-N	R56-49	19.88	17.81[h]	2.08	0.65	1.36	0.17	0.16	22.23[d]	89.6	8.56
	Clark-63	25.57	24.49[g]	1.08	0.72	1.33	0.17	0.19	27.98[e]	95.8	22.68
	Mean	19.49	17.87	1.62	0.68	1.29	0.18	0.17	21.82	91.7	11.03
Grand	Mean[5]	14.36	12.72	1.64	0.71	1.57	0.18	0.17	16.95	88.5	7.73

[1]Any two means followed by the same letter within phosphorus do not differ significantly at the 5% level.

[2]There is no significant difference at the 5% level between any two means within ASOP, LP, RNA-P, DNA-P and RP.

[3]P mg/g d.w. in the third trifoliate from the top. Mean of 3 replicates.

[4]Calculated on the basis of 10% phosphorus.

[5]All means are not calculated from the data in this table.

Table 2. The effect of Nitrogen Source on Different Phosphorus Fractions in Soybean Leaves with Different Phosophorus Sensitivity.

		ASP	ASIP	ASOP	L-P	RNA-P	DNA-P	R-P	T-P	ASIP/TP ×100	ASIP/ ASOP
	Hill	8.70*	6.50	2.20	0.80	1.67	0.22	0.10	11.49	56.6	2.75
NO_3-N	Harosoy	17.68	14.00	3.68	0.70	1.09	0.10	0.08	19.65	71.3	3.80
	Chippewa	18.45	16.00	2.45	0.90	1.08	0.16	0.09	20.68	77.4	6.52
	Mean	14.94	12.17	2.78	0.80	1.28	0.18	0.09	17.27	70.5	4.34
	Hill	14.58	12.50	2.08	0.95	1.76	0.17	0.12	17.58	71.1	6.02
NH_4-N	Harosoy	22.13	20.50	1.63	1.05	1.92	0.21	0.16	25.47	70.5	12.61
	Chippewa	20.98	19.50	1.34	1.02	2.03	0.19	0.16	24.24	80.5	14.50
	Mean	19.19	17.50	1.68	1.01	1.90	0.19	0.15	22.43	78.0	10.42
	Hill	18.71	16.50	2.21	0.69	1.21	0.11	0.11	20.83	79.2	7.48
Urea-N	Harosoy	32.00	30.50	1.50	1.13	1.68	0.14	0.16	35.11	86.9	20.34
	Chippewa	26.58	25.50	1.08	0.92	1.37	0.11	0.11	29.09	87.7	23.52
	Mean	25.76	24.15	1.60	0.91	1.42	0.12	0.13	28.34	85.2	15.09

* P mg/gm dry weight in the third trifoliate from the top. sigle run.

is not significant for total phosphorus. For the phosphorus content in the metabolic pool, there are significant 2nd and 3rd order interactions among pool, variety and nitrogen source (0.01P) From these facts it appears that the effects of nitrogen source and variety are more concerned with specific metabolic pools rather than total phosphorus.

The greatest influence of nitrogen source and variety is on ASIP with the level of ASIP significantly different (Table 1). All other fractions except DNA-P increased when the ASIP increased and considerable differences are shown between variety and nitrogen source (Table 1). The effects of nitrogen source and variety on ASIP are shown in Figure 1. The highest ASIP is found in the urea treated plants in all varieties and lowest in nitrate treated plants(Tables1, 2).

The varietal growth difference in the nitrate medium is not as great as the difference in ASIP content. ASIP is the pool most sensitive to the outside medium and seems to have a major role in phosphorus metabolism and consequently in plant growth. Thus, the dry matter yield has a significant correlation with ASIP as shown in Figure 2 The lowest dry matter yield is in the

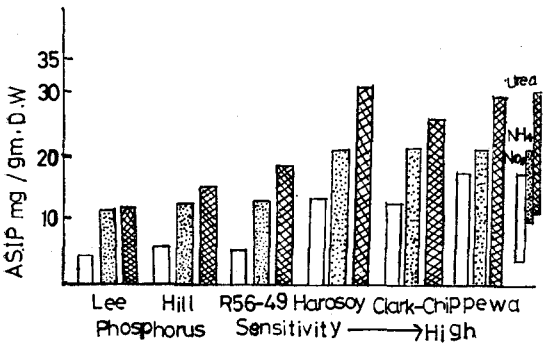


Figure 1. The Content of Acid Soluble Inorganic Phosphorus (ASIP) in the Leaves of Soybean Varieties Grown in Various Nitrogen Sources.

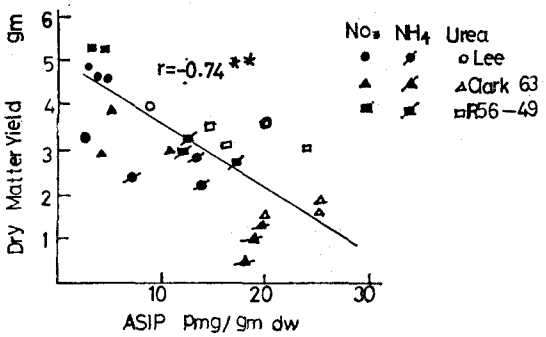


Figure 2. Relationship of Nitrogen Source and Soybean Variety on Dry Matter Yield and Acid Soluble Inorganic Phosphate. **significant at 0.01P

ammonium fed plant even though the ASIP is less than in the urea fed plant. This indicates possible interaction between ammoninm excess and phosphorus-excess. It may suggest that phosphorus-excess is favored in ammonium excess situations or that a special unknown urea effect aleviates phosphorus-excess.

The relations between dry matter yield and each phosphorus fraction are shown in Table 4. The greatest negative correlation coefficient is found between dry matter yield and ASIP as mentioned previously. Residual phosphorus also has significant negative relations with dry matter yield. It is interesting that ASOP and DNA-P have a positive relation to dry matter yield but RNA-P has a negative relation. Total phosphorus content is mainly affected by ASIP. ASOP has a positive relationship with L-P, RNA-P. This may indicate that these four pools are closely related in a similar way in phosphorus metabolism. R-P might represent metabolic inactivation of phosphorus. RNA-P was significantly correlated only with L-P. DNA-P showed the highest positive coefficient with L-P but not significant.

The percent ASOP in ASP is shown in Figure 3. The percent ASOP decreased when ASIP increased. Phosphorus sensitive varieties always show higher ASIP in all three nitrogen sources. ASIP seems related to phosphorus sensitivity, and also has consistent change in relation

Table 3. Analysis of Variance for the Effect of Nitrogen Source on Phosphorus Fractions in Soybean Leaves

Source of Variation	df	SS	MS	F
Replication	2	2.0642	1.0321	0.60
Nitrogen (N)	2	122.7005	61.3503	35.41**
Error (a)	4	6.9313	1.7328	
Variety (V)	2	42.0682	21.0341	5.15*
V.N	4	14.5158	3.6289	0.89
Error (b)	12	49.0095	4.0841	
Phosphorus fraction (P)	5	3226.8675	645.3736	387.36**
P.N	10	587.5592	58.7559	35.27**
P.V	10	263.4398	26.3440	15.81**
P.V.N	20	152.4040	76.2020	45.74**
Error (c)	90	149.9450	1.6661	
Total	161	4617.5050		

*Significant at 0.05P. **Significant at 0.01P.

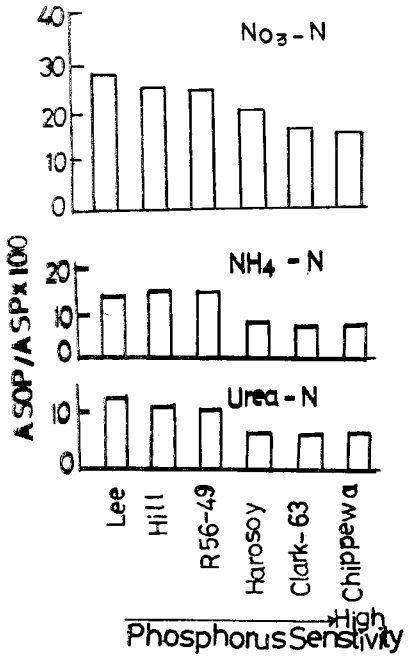


Figure 3. Nitrogen Source Influence on the Percent of Acid Soluble Organic Phosphorus (ASOP) in the Total Acid Soluble Phosphorus (ASP) of Different Phosphorus Sensitive Varieties.

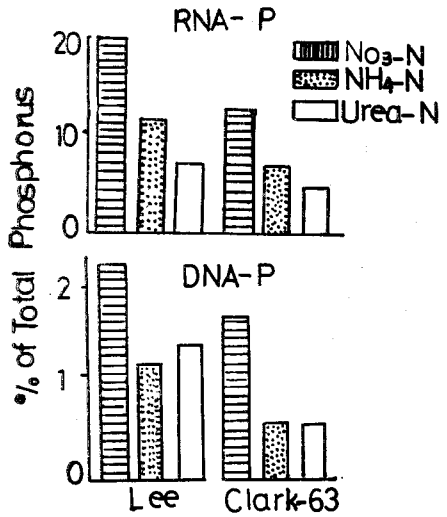


Figure 4. Percent RNA-P and DNA-P of Total Phosphorus in Soybean Leaves affected by Nitrogen sources.

Table 4. Analyses of Corrleations of Phosphorus Fraction and Dry Matter Yield from Soybean Leaves.

	T-P	ASP	ASIP	ASOP	L-P	RNA-P	DNA-P	R-P
Yield[1]	−.8358**	−.8244**	−.8368**	.4059	−.1466	−.1788	.3921	−.6898*
T-P		.9985**	.9961**	−.1732	.1342	−.0597	−.3540	.6404*
ASP			.9986**	−.1906	.0892	−.0259	−.3633	.6289*
ASIP				−.2432	.0378	−.2239	−.3723	.6334*
ASOP					.3677	.2578	.2444	−.2201
L-P						.6277*	.5283	.0068
RNA-P							−.0714	.2010
DNA-P								−.4642

** Significant at 0.01P. * Significant at 0.05P. T-P, Total P; ASP, Acid soluble-P, (ASIP+ASOP); ASIP, Acid soluble inorganic-P; L-P, Phospholipid-P. 1Dry matter.

Table 5. The effect of Nitrogen Source on Different Phosphorus Fraction in Soybean Roots That Differ in Phosphorus Sensitivity.

		ASP	ASIP	ASOP	AIP	T-P	AOP/ASP×100	ASP/ATP
	Lee	15.75*	12.60	3.15	3.40	19.15	20.0	5.6
NO_3-N	R56-49	24.00	18.00	6.00	3.70	27.70	25.0	7.5
	Clark-63	18.75	14.40	4.35	3.30	22.05	23.2	6.7
	Mean	19.50	15.00	4.50	3.47	22.97	23.1	5.6
	Lee	19.60	19.00	0.60	2.10	21.70	3.1	9.3
NH_4-H	R56-49	21.45	20.80	0.65	2.20	23.65	3.0	9.7
	Clark-63	27.00	26.40	0.60	2.60	29.60	2.2	10.4
	Mean	22.68	22.07	0.62	2.30	24.98	2.7	9.9
	Lee	20.25	19.80	0.45	3.00	23.25	2.2	6.8
Urea-N	R56-49	30.60	29.70	0.90	2.90	33.50	2.9	10.5
	Clark-63	31.68	31.00	0.68	3.46	34.14	2.2	9.1
	Mean	27.51	26.83	0.68	3.12	30.30	2.5	8.8

* P mg/g d.w. single run. ASP, Acid-soluble-P (ASIP+ASOP); ASIP, Acid- soluble inorganic-P; ASOP, Acid-soluble organic-P; AIP, Acid-insoluble-P; T-P, Total-P (ASP+AIP).

to nitrogen source. However, the percent ASOP seems to be in closer relation to phosphorus sensitivity than ASIP. This indicates that ASOP or the ratio of ASOP/ASIP has the most active role in metabolism. This also show the importance of a balance between ASOP and ASIP. In the urea fed plant, the percent ASOP is less than that in the ammonium fed plant in spite of greater ASIP. The relative magnitude of RNA and DNA fractions are shown in figure 4. The percent RNA or DNA of total phosphorus in Lee was about twice that of Clark-63.

The highest phosphorus fractions in the roots showed a similar tendency as in the leaves, as shown in Table 5. The percent ASOP in the ammonium and urea supplied root is much less than that in the nitrate supplied root. The percent ASOP in the nitrate supplied root is about 10 fold higher than other treatments. This indicates that phosphorus metabolism is affected by nitrogen source more signficantly in the roots.

The phosphorus content in the RNA fraction

obtained by the acid digestion method ranged from 9.5% to 11%. Nitrogen source seems to have a certain effect on the phosphorus content in the RNA fraction.

DISCUSSION

Phosphorus sensitivity is related to t he plant growth in the high phosphorus medium (7) and the sensitive variety has greater absorption power in the root (6). This phenomenon is agreed with the results of the present investigation. (Tables 1, 2, 5, Fig. 1) The interesting point is that the ammonium effect on phosphorus uptake consistently increases with phosphorus sensitity. The mechanism of the stimulatory uptake of phosphorus by ammonium is still unknown. The fact that phosphorus concentration is even higher in urea fed plant than ammonium fed plant (Fig. 1) makes more complex in relation to phosphorus uptake and companion ions. Factors to govern phosphorus uptake should be changed depending on nutrient medium along with growth.

The decrease of the RNA level in high phosphorus tissue was pointed out as a probable metabolic characteristic (8). The RNA increase with phosphorus increase in tissue (Tables 1, 2) is in contrast to the above observation. Considering the protein/RNA value varies over a wide range (16), the possibility of RNA as a phosphorus sensitivity index would be slight. The relative size of RNA or DNA-P pool may he better as sensitvity index. The percent RNA-P or DNA-P of total phorphorus in the mitrate treated plant was twice that in the ammontum treated plant, which were also higher in tolerant cultivars regardless of nitrogen sources (Fig. 4). The percentage of acid soluble organic phosphorus to acid soluble phosphorus (ASOP/ASP×100, Fig. 3) would be a better index of phosphorus sensitivity. The gradual decrease of this value indicates that inorganic phosporus increased gradually. The phosphorus sensitivity may be defined as the difference between phosphorus assimilation capacity and phosorphorus absorption capacity since the inorganic phosphorus level is a function of uptake and assimilation. In other words the sensitivity is the size of the primary pool relative to the secondary pools. If a variety has greater absorption capacity than assimilation capacity, the ratio of the organic phosphorus to inorganic phosphorus will be small, and the plant is a sensitive variety. One may also postulate that the high phosphorus absorption power might be an adaptive development from the low phosphorus environment while the tolerant varieties have developed in the high phosphorus soil.

The fact that the residual phosphorus has a negative correlation with plant growth and a positive correlation with inorganic phosphorus (Table 4) strongly suggests that the phosphorus sensitivity index is not merely the ratio of total organic to inorganic but better the acid soluble organic phosphorus to inorganic phosphorus.

From the above point of view, one may speculate that the phosphate potential ((ATP)/(ADP)(Pi)) (10) is closely related to ASOP/ASP. If we can measure the phosphate potential it would be a more appropriate index of phosphorus sensitivity, eventhough phosphorus toxicity is related to the inactivation of Zn (1), Fe (15) and Cu (5). Under an extremely high Pi or above a certain critical level ATP could not be utilized as an energy source eventhough ATP is available since Pi inhibits the process of energy transfer as follows:

$$ATP \leftrightharpoons E+ADP+Pi$$

Under such conditions, the respiration might be increased in a way similar to the uncoupling of oxidative phosphorylation. The adverse effect of accumulated phosphate was the aggravation of excessive respiratory losses when barley showed potassium deficiency (4).

Phosphate potential ((ATP)/(ADP) (Pi)) is proportional to (NADH)/(NAD^+) in the cytoplasmic compartment and a similar relationship occurs in the mitochondrial compartment. There is a close relation between these two cellular compartments concerning these ratios. They have a decisive role at various control points for the direction and pace of all metabolism. The degr-

adative, catabolic, energy-yielding sequences generally involve NAD^+ while biosynthetic, energy requiring ones almost invariably required NADPH (20).

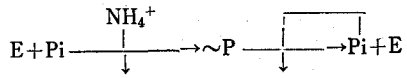
According to phosphorus fractions in the root (Table 5) a more aggravated situation of phosp horus potential might be expected than occurred in the leaves. The phosphorus potential seems not only limited to cytoplasm and mitochondria. It has possibly an even greater role in the nucleus. In the recent study of orthophosphate distribution in the cell, about 30% and up to 50 % of the total cellular orthophosphate is accumulated in the nucleolus of maize root tip cells (9). This indicates that phosporus increase in the cell primartily affects the phosphorus level in the nucleus. The high level of phosphorus in the nucleus may inhibit the replication and transcription by a similar mechanism of phosphate potential. If the DNA production is arrested or retarded, the cell division will be arrested and growth is inhibited, eventhough the DNA-P contents per dry weight show little change (Tables 1, 2).

If the sensitivity concept as the difference between assimilation and uptake is applied to ammonium sensitivity, it is well expected that the amonium sensitive variety has greater ammonium absorption power than assimilation into protein. Nitrogen content tends increase with phosphorus sensitivity especially in the root (unpublished). Ammonium and phosphorus sensitivity are common in rapid uptake of ammonium or phosphorus which causes a stimulation on metabolisms in the early growth stage.

In the urea treated plant phosphorus content is greater than in the amonium treated plant (Fig. 1) but growth is better (12). Poorer growth of ammonium fed plant might be due to ammonium toxicity rather than phosphate potential because ASOP/ASP is greater in urea treated plant than ammonium treated plant (Tables 1, 2), Phosphate potential could be aleviated by certain organic phosphorus compounds such as carbomylphosphate in the urea plant.

Ammonium ion was reportted as inhibitor of cyclic photophosphorylation (11), reversible uncoupler of Hill reaction phosphorylation and also uncoupler of oxidative phosphorylation (18). Ammonia is an inhibitor in oxidation of NADH (19). The precise mechanism of amonium toxicity, however, is still unknown.

It is, therefore, expected that ammonium treated plants might suffer a drastic shortage of ATP and impairment of biological energy conversions. Furthermore, the ammonium toxicity seems to have an effect similar to Pi on phosphate potential by lowering the ATP level. The effects of NH_4^+ and Pi on energy transfer can be shown as follows:



Where E indicates energy and~P indicates high energy phosphate bond ammonium inhibits the formation of high energy bond and high inorganic phosphate inhibits energy release from high energy bond. Thus, ammonium affects the ATP term while inorganic phosphate affects the Pi term inthrough phosphate potential.

There may be numerous cases of similirality between ammonium ion and inorganic phosphorus in metabolic cycles such as glycolysis.

摘　　要

燐酸感受性이 다른 大豆를 암모니움태, 질산태, 뇨소태질소의 배양액에길러 葉과 根에서 RNA, DNA 및 기타 燐酸形態를 정량하였다. 燐酸感受性인 品種은 耐性인 品種보다 모든 窒素源에서 酸可溶無機燐酸含量이 높았다. 酸可溶無機燐酸은 尿素培養에 가장 높았고 窒酸態培養에서 가장 낮았는. 全燐酸 含量은 酸可溶無機燐의 增加에 依하여 가장 影響을 받았다. 酸可溶無機燐酸이 增加하면 酸可溶有機燐酸, 脂質燐酸 리보核燐酸과 殘餘燐酸이 增加하는 傾向이나 데옥시 리보核酸은 변화가 거의 없었다.

窒酸態培養植物에서 全燐酸에 對한 리보 核酸燐이나 데옥시리보核酸燐의 百分率은 암모니움 培養의 그것보다 두배가 되었으며 窒素源에 關係없이 耐性品種에서 역시 높았다. 全酸可溶燐에 對한 酸

可溶有機燐의 百分率은 燐酸感受性이 적을수록 적었다. 燐酸感受性은 燐酸代謝물의 相對的 크기에 依存됨을 나타낸다.

全乾物生産量은 全燐酸含量과 負相關이고 (−0.84로 1%水準有意) 酸可溶無機燐 (−0.84로 1% 水準有意)이나 殘餘燐 (−0.69로 5% 水準有意)과도 負相關이었다. 酸可溶有機燐은 脂質燐, 리보核酸燐 및 데옥시 리보核酸燐과 正의 相關性을 보이나 殘餘燐과는 負의 關係였다. 리보核酸燐은 脂質燐과만 有意正相關(0.63, 1% 水準)을 갖는다.

窒素源, 品種 그리고 燐酸代謝물 間에는 有意性있는 (1%水準) 交互作用이 있었다.

燐酸感受性과 암모니움害毒은 에너지 代謝面에서 同一한 것으로 보였다. 即 前者는 아데노신 3 燐酸을 아데노신 2 燐酸으로의 轉換(에너지방출)을燐酸 포텐샬을 통해 저해하며 後者는 아데노신 3 燐酸의 生成(에너지 貯藏)을 저해하는것 같다.

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