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Efficiency of Soil and Fertilizer Nitrogen in Relation to Rice Variety and Application Time, Using ^{15}N Labled Fertilizer[1].

Ⅳ. Pot experiment for split application of ^{15}N-Urea

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重窒素를 利用한 水稻品種 및 施用時期에 따른 土壤 및 施肥窒素의 效率

Ⅳ. ^{15}N 尿素의 分施폿드試驗

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抄 錄

重窒素尿素를 使用 3品種에 對한 分施試驗을 폿드에서 수행하였다. 2回分施는 4回分施보다 統一系에 월등히 좋았다. 施肥效率(Fe), 利用率 및 吸收施肥窒素效率(Ef)은 4回分施보다 2回分施에서 월등히 컸다. Fe의 순위는 Ef의 순위와 같았다. 收量과 重素窒過剩率은 統一系가 生育初期에 施用窒素를 많이 吸收하여 後期에 상당히 再轉流시킴을 나타내었다. 吸收施肥窒素에 對한 土壤窒素吸收增加量 (ΔNs/Nf)은 施肥로 因한 土壤窒素利用率의 指標가 될 수 있다.

Introduction

Newly bred Tongil line (Japonica×indica hybrid selection) showed higher yield than the leading local varieties in the countrywide NPK simple trial[2] and such high yielding capacity seems to be related principally to high nitrogen efficiency[3,4]. Since this nitrogen efficiency was calculated by difference method the reassessment by labeled method seems to be of worth. Furthermore the labeled method will give better information about relation between fertilizer nitrogen and one from soils. This pot experiment on split application was carried out together with ^{15}N top-dressing in fields[5] for the prelim-

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inary information among varietal characteristics prior to the point and split application experiment of labeled fertilizer in various farmers fields.

Materials and methods

A pot (1/5000a) experiment was carried out by using ^{15}N labeled urea with Jinheung (Japonica), Early Tongil and Yusin (Tongil line). A poor silty loam soil (organic matter 1.04% and nitrogen 0.085%) was used. ^{15}N urea (5 atom %) was applied as solution on surface and puddled with a glass pole about 5cm depth. There were two nitrogen split treatments, one 40, 30, 20, 10% split application at basal, maximum tillering, ear formation and heading stage respectively and the other two-split application(70 % basal and 30% at ear formation stage).

One seedling per pot was transplanted on 26 June. Three of total six replications were treated with ^{15}N urea. There were also 3 replications of no nitrogen treatment. Fertilizer rate was 16kg/N/10a, Aerial part were sampled at harvest and analysed as mentioned previously[5]. A-value was also calculated[1]. Soil nitrogen increment in plant (NS) was calculated by subtraction of total nitrogen uptake of no fertilizer plot from total soil nitrogen in plant of fertilizer plot.

Results and discussion

Yield components were shown in Table 1. Yield was higher in 2-split than in 4-split application for all three varieties. The 2 split application was much more effective to Tongil lines. Unusual effect of 2-split application

Table 1. Growth and dry matter yield of rice varieties in split application.

		Grain	Leaf sheath and culm	Leaf blade	Whole plant	Harvest index	Panicle/ hill	Spikelet/ panicle	Grain weight
		(g/hill)				(%)			$\times 10^3$
4-split (40-30-20-10)	*Jinheung*	26.8	19.8	8.8	55.4	48.4	17.3	225	26.9
	Tongil	17.6	10.4	6.8	34.8	50.6	15.7	839	25.1
	Yusin	23.6	13.6	9.6	46.8	50.4	14.7	1150	22.2
2-split (70-30)	*Jinheung*	30.4	16.7	8.6	55.7	54.6	15.0	1196	22.7
	Tongil	31.3	11.8	8.3	51.4	60.9	18.3	1617	24.3
	Yusin	34.0	15.0	11.4	61.0	56.7	21.7	1785	21.7

4-split: at transplanting, maximum tillring, ear formation and heading
2-split: at transplanting and ear formation

seems to be due to very low air temperature in september, 1976. In such a year yield depends much on the growth in early stage thus on the introgen absorption of early stage.

^{15}N excess % in whole plant was greater in 4-split application except Early Tongil (Table 2). Tongil is panicle and spikelet number type and thus requires more nitrogen in early stage[8]. Yusin is a sister variety of Tongil but many characteristics are inbetween, especiallly in grain quality.

^{15}N excess % in various plant parts was in

Table 2. ^{15}N excess % of rice varieties in split application.

		Grain	Leaf sheath and culm	Leaf blade	Whole plant
4-split (40-30-20-10)	*Jinheung*	3.56	2.80	2.96	3.36
	Tongil	3.72	3.16	3.18	3.53
	Yusin	3.72	3.07	3.58	3.57
2-split (70-30)	*Jinheung*	3.36	2.66	2.92	3.20
	Tongil	4.00	3.20	3.22	3.81
	Yusin	3.68	2.92	3.03	3.47

decreasing order of grain>leaf blade>leaf sheath plus culm as shown under the field condition[5]. The difference of nitrogen excess between grain and leaf blade depends on absorption of ^{15}N and retranslocation of ^{15}N to grain. If the ^{15}N excess % of grain depends more on retranslocation from leaves than on the direct absorption to grain through culm after heading the difference may become larger, especially when the ^{15}N absorption is relatively lower in the later stage. The larger difference in 2-split application than in 4-split in Tongil and Yusin seems to agree with such assumption and consequentlyindicates better absorption of fertilizer nitrogen in early stage.

Percent nitrogen derived from fertilizer (Cf) and other nitrogen efficiencies were shown in Table 3. In all three varieties and two application methods the Cf was greater than 70% except Jinheung in 2-split. Such high percentage of fertilizer nitrogen may be attributed to the low fertility of soil. Cf was in order of grain> leaf blade> leaf sheath plus culm. The percent

Table 3. Various nitrogen efficiencies of rice plant measured by using ^{15}N fertilizer

		Cf(%)				Tn	Tnf
		G	LS+C	LB	W	(%)	(%)
4-split	*Jinheung*	76.9	60.5	63.9	72.5	69.9	74.2
	Tongil	80.4	68.3	68.7	76.2	64.8	68.4
	Yusin	80.4	66.3	77.3	77.2	63.0	65.5
2-split	*Jinheung*	72.6	57.5	63.1	69.2	74.2	77.8
	Tongil	86.4	69.1	69.6	82.3	75.9	78.7
	Yusin	79.5	63.1	65.4	74.9	70.0	74.2

Cf: Percent nitrogen derived from fertilizer in plant, G: Grain, LS+C:Leaf sheath+culm, LB: Leaf blade, W: Whole plant (Top), Tn: Percent translocation of nitrogen to grain, Tnf: Percent translocation of ^{15}N grain.

translocation of nitrogen to grain(nitrogen in grain×100/nitrogen in whole plant) was greater in ^{15}N(Tf) than in total nitrogen (Tn). The difference between Tf and Tn was greater in Jinheung than Tongil line with 4-split application and it was quite reverse with 2-split application. This fact may indicate more direct fertilizer absorption to grain in Jinheung with 4-split in the later stage. Relatively greater difference of Cf or excess % of ^{15}N between leaf sheath plus culm and leaf blade in Jinheung than in Early Tongil suggests Tongil develops the better retranslocation system which appears to be closely related to the fast retranslocation of ^{32}P from upper leaves to grain[6] due to greater sink/source ratio[7]. Retranslocation system in Yusin may be much the same to Jinheung as there was similarity in leaf senescence.

The use efficiency of fertilizer nitrogen when calculated by difference method was about 5% greater than that calculated by ^{15}N (Table 4). If exchange between ^{15}N and ^{14}N in soils is negligible this 5% difference must be assigned to an augmented uptake of soil nitrogen probably due to fertilizer stimulated root growth. The fertilizer use efficiency of Jinheung that has been known as better adaptive to split application was greater than that of Tongil under 4-split but it was reversed under 2-split.

Fertilization efficiency(Fe; increased grain kg per nitrogen kg applied), and absorbed fertilizer nitrogen efficiency(Ef) were greater in Jinheung than in Tongil line. This varietal difference is somewhat reverse of the results from the field experiment[4]. Such reverse results may be due to difference in soil condition between pot and field. The comparison between two systems needs. Weather factor due to the late transplant-

Table 4. Various nitrogen efficiencies of rice plant measured by using ^{15}N fertilizer.

		Fe	Eud	Eu	Efd	Ef	⊿NS	⊿NS/	A value
			(%)	(%)			(mg/hill)Nf		N kg/10a
4-split	*Jinheung*	24.3	33.0	29.8	73.8	81.6	30.8	10.6	6.07
	Tongil	10.1	27.2	24.3	37.2	41.7	38.7	12.2	5.00
	Yusin	13.2	33.4	30.2	39.5	43.7	42.4	10.8	4.73
2-split	*Jinheung*	26.0	33.7	29.0	77.0	89.6	40.3	16.3	7.12
	Tongil	20.6	41.5	38.0	49.7	54.3	46.4	9.4	3.44
	Yusin	21.6	39.1	33.5	55.3	65.5	72.9	16.7	5.36

Fe: Fertilization efficiency (grain kg/N kg applied), Eud: Use efficiency by difference method, Eu Use efficiency ^{15}N by method, Efd: Efficiency of absorbed nitrogen from fertilizer by difference method, Ef: Ef by ^{15}N method, Ns: Soil nitrogen increment due to fertilizer application, Nf: Nitrogen derive from fertilizer.

ing may be concerned. The order of Fe, however, followed the order of Cf regardless of variety and application method (Table 4) as reported in field condition[4].

Ef must be greater than Efd(Ef by difference method) since Nfd (nitrogen derived from fertilizer by difference method) is always greater than Nf. Soil nitrogen increment due to fertilizer application(⊿Ns) ranged 31mg to 73mg per hill and was much greater in Tongil than in Jinheung. The ratio of ⊿Ns to Nf was almost same between Jinheung and Yusin but quite different in Early Tongil. ⊿Ns ranged 9 to 17% of Nf. The A value was greater in Jinheung than in Tongil line and did not show any consistency between split application.

⊿Ns/Nf may indicate the interaction between soil nitrogen and fertilizer nitrogen. Furthermore it may be an index of soil nitrogen use efficiency by fertilizer nitrogen.

Abstract

Top-dressing pot experiment with ^{15}N urea was carried out by using three varieties. Two-split application was much better for Tongil line than 4-split. Fertilization efficiency (Fe), use efficiency (Eu) and absorbed fertilizer nitrogen efficiency (Ef) were much greater in 2-split than in 4-split. The order of Fe followed that of Ef. Grain yield and ^{15}N excess % among plant parts suggest that Tongil line uptakes fertilizer nitrogen much in early stage and retranslocated well later. The order of soil nitrogen increment in plant per fertilizer nitrogen in plant (⊿Ns/Nf) might be an index of soil nitrogen use efficiency due to fertilizer.

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