氏　　　　　名	NGUYEN QUANG CO
授与した学位	博　士
専攻分野の名称	農　学
学位授与番号	博甲第５１６９号
学位授与の日付	平成２７年　３月２５日
学位授与の要件	環境生命科学研究科　農生命科学専攻 （学位規則第５条第１項該当）
学位論文の題目	Cultivational studies on the improvement of nitrogen use efficiency in rice cultivars （水稲品種における窒素利用効率の向上に関する栽培学的研究）
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学位論文内容の要旨

Rice is one of the most important cereal crops, widely grown in may localities with favorable climatic conditions throughout the world. Nitrogen (N) is not only necessary for rice growth but also the most important nutrient in lowland rice production all over the world. N plays an important role in increasing dry matter production and grain yield. In order to improve rice yield to satisfy the food demands, farmers use high-yielding cultivars and excessively apply N fertilizer.

To clarify the relationship between dry matter production, grain yield and nitrogen use efficiency, we conducted the field experiments at the Field Science Center, Okayama University. 1) effects of different types of fertilizers and methods on dry matter production, grain yield and nitrogen use efficiency of rice cultivars, 2) cultivar differences in nitrogen use efficiency at different levels of nitrogen fertilizer, and 3) genotypic differences in dry matter production, yield and nitrogen use efficiency in selected rice cultivars without nitrogen fertilizer, were examined.

In chapter 2, we used two rice cultivars (Nipponbare and Takanari) and five fertilizer methods. Dry matter production was increased more markedly with nitrogen fertilizer application than that in control, and it was higher with deep fertilizer application in Takanari and standard fertilizer application in Nipponbare, respectively. Plants with higher CGR and mean LAI during this stage might be resulted in higher grain yield at harvest. Higher N accumulation contributed to larger sink capacity. Higher fertilizer application increased the number of panicle and total spikelets m^{-2}. The higher grain yield in Takanari resulted from the larger sink capacity. The grain yield of rice cultivars tended to be higher with deep fertilizer application due to the increase in sink capacity. The uses of slow-release fertilizer is recommended in terms of labor saving and lower cost.

In chapter 3, experiments were conducted during two years 2011 and 2012. Six rice cultivars were used in 2011 and two more cultivars in 2012, respectively. All cultivars were grown at three levels of nitrogen fertilization (0N: 0 gN m^{-2}; 1N: 8 gN m^{-2}; 2N: 16 gN m^{-2}). Dry matter production became higher in all cultivars with higher nitrogen application during two years. Dry matter production at harvest was highest in Takanari and Hokuriku 193. Takanari consistently accumulated the largest amount of N at 2N. The grain yield of Takanari was highest during the 2 years (750 g m^{-2} and 731 g m^{-2} at 1N in 2011 and 2012, respectively) followed by Hokuriku 193 (669 g m^{-2} at 1N in 2012). Nitrogen use efficiency (YE_N) decreased with the raising of N levels and it was higher in Hokuriku 193 and Takanari. Both cultivars showed the highest yield among 0N plots (589 and 562 g m^{-2}) due to the highest YE_N and sink formation capacity (sink capacity / accumulated N at panicle initiation).

In chapter 4, we investigated the genotypic differences in dry matter production, grain yield and nitrogen use efficiency in some selected rice cultivars. In this experiment, 49 rice cultivars (which were selected from NIAS Global Rice Core Collection, Rice Core Collection of Japanese Landraces and recently developed high-yielding cultivars) were grown in field condition without N fertilizer. The results showed that high-yielding (HY) cultivars and some cultivars like W 2 (Kasalath), W 10 (Shuusoushu), W 30 (Anjana Dhan), J10 (Hirayama), J 23 (Ishijiro) J 36 (Sekiyama), W 18 (Qingyu) and J 26 (Aikoku) produced the higher dry matter production, grain yield and harvest index (HI) to compared with other cultivars. These cultivars could accumulate a larger amount of nitrogen probably from the soil than the other rice cultivars and adapt to low levels of N fertilizer.

The overall results demonstrate that deep fertilizer application is a good way for rice cultivar to uptake more nitrogen fertilizer. Gain yields of Takanari, Hokuriku 193, Akamasari and Hinohikari were the highest at 1N levels because of higher dry matter production, HI and N use efficiency for grain (YE_N). Some rice cultivars could accumulate a larger amount of N and produce higher grain yield. These cultivars can adapt with low levels of N fertilizer. High-yielding cultivars showed the higher yield and YE_N not only under standard fertilization, but also under without N fertilization.

論文審査結果の要旨

本学位申請論文は，施肥資材，施肥量，施肥方法の違いが水稲品種の生育収量，乾物生産，窒素利用効率に及ぼす影響およびイネコアコレクション，そして近年育成された水稲多収性品種を用いて，異なる施肥レベルにおける窒素利用効率の品種間差を検討することを通じて，水稲品種における窒素利用効率の向上を栽培学的に検討したものである。

試験 I では，水稲の乾物生産，収量，窒素利用効率に及ぼす肥料と施肥法の影響を検討した。窒素施肥とともに，乾物生産が増大し，最終乾物重はタカナリでは深層追肥区，日本晴では標準緩効性肥料基肥施肥区で最も高くなった。窒素蓄積量は両品種ともに深層追肥区で多くなった。タカナリの収量が高いことには，シンク容量が大きいことが関係した。深層追肥区，標準緩効性肥料基肥施肥区ともに慣行施肥区に比べ窒素回収効率，部分要因生産性ともに向上したが，省力・低コストの観点からは施肥効率の高い緩効性肥料の利用が推奨された。

試験Ⅱでは，水稲多収性品種を 3 段階の窒素施肥レベルで圃場栽培を行い乾物生産，収量と収量構成要素，窒素蓄積量と窒素利用効率の品種間差を検討した。タカナリは両年ともに 2N 区で窒素蓄積量が最も大きくなった。タカナリの玄米収量は 2 ヵ年とも 1N 区で最も高く（750, 731 gm^{-2}），ついで北陸 193 号（669 gm^{-2}, 1N 区, 2012 年）で高くなった。いずれの窒素利用効率も，窒素施肥量の増加とともに小さくなり，品種間では北陸 193 号とタカナリが高い値を示した。両品種とも 0N 区の収量が他品種に比べ高い値を示し（589，562 gm^{-2}，2012 年），これにはシンク形成能（シンク容量／幼穂分化期の窒素蓄積量）が高く，シンク容量が大きくなったことが関係していた。

試験Ⅲでは，イネコアコレクション，そして近年育成された水稲多収性品種を用いて，無窒素施肥条件下で栽培を行い，多くの多様性をもつ品種群の中でも，試験Ⅱで多収性が認められた，タカナリと北陸 193 号は，高い収量，窒素利用効率を示すことが再確認された。

以上より，高い収量は大きなシンク容量，高い乾物生産・窒素利用効率によってもたらされ，これらにはシンク形成能が高いことが関係することが明らかとなった。今後，シンク形成能の高い品種の選抜により，窒素利用効率の高い低投入多収性品種の育成が可能となることを示した点で高く評価される。

以上の理由により，博士（農学）の学位を授与するに十分値するものと認める。