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EFFECTS OF LIMITED SPACE ON FOLIAGE DEVELOPMENT IN RICE PLANTS***

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Abstract

To investigate intra-hill competition in rice, growing space for foliage development was limited and light conditions were changed by inserting a clear or black plastic board to pots which had the same undergroud conditions.

The plant length at panicle formation stage became longer as growing space decreased. At maturity, limiting growing space did not influence plant height.

The number of tillers in shaded plots was smaller than that in non-shaded plots, and could be expressed by a linear regression between number of tillers and different growing spaces.

The relationship between dry weight of leaf blade and growing space in non-shaded plots at panicle formation stage was expressed by quadratic regression curves. At heading time, relationship was expressed by linear equations in both shaded and non-shaded plots. This suggests that growth of each organ after heading varied in translocation and accumulation of internal substances.

The nitrogen content percentage of leaf blades at panicle formation stage incresed with decreasing growing space, and could be expressed by a linear regression; Nitrogen content % was higher in shaded plots than in non-shaded plots. In non-shaded plots, however, no relationship was observed between nitrogen content percentage and growing space, indicating possible involvement of light conditions in the nitrogen content percentage. At heading time, the nitrogen content percentage of leaf blade and culms was expressed by linear equations. At maturity, in non-shaded plots varying growing space was no influence nitrogen content. In conclusion, rice plants grown under shaded conditions with more limited space had a significant reduction on the number of ears and the amount of nitrogen translocated from foliage to ear. This might be associated with the sink-source relation.

Introduction

One hill of transplanted rice consists of several seedlings, resulting in both intra-hill competition and inter-hill competition in the rice community[2, 3, 4, 9]. Inter-hill competition begins at different times depending upon distances between hills and growing stage of individual plants, while intra-hill competition obviously begins just after transplantation to paddy field.

This study was conducted to investigate the relationships between intra-hill competition and the interaction of each organ in the individual plant. Space for foliage development was restricted by either clear plastic boared or black plastic board placed at various angle. Underground conditions were not changed. Morphological characteristics and nitrogen content were examined at panicle formation, heading and maturity. Clear plastic board limited physical space only, while black board limited both physical space and light conditions.

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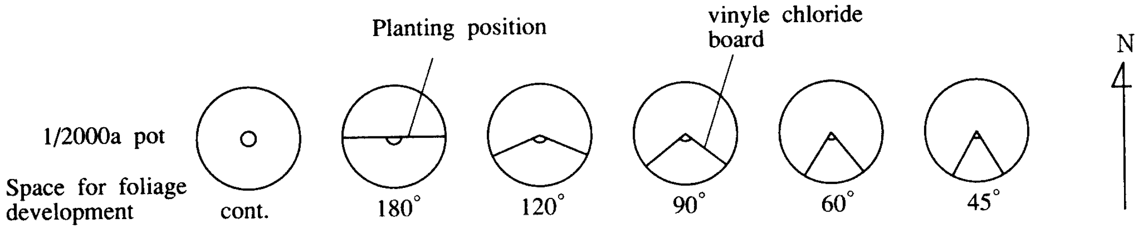

Fig. 1 . Experimental pots

Materials and Methods

This study was carried out at the Experimental Farm, Faculty of Agriculture, Kobe University in 1985.

Young seedlings of rice(Oryza sativa L. cv. Nipponbare) were transplanted to 1 / 2,000 a Wagner pots at leaf age 3.5. Each pot consisted of one seedling. These pots were spaced one meter apart from each other to prevent interactions between plants and were buried to ground level to avoid rising soil temperature. Two gram each of N, P_2O_5 and K_2O chemical fertilizers were applied per pot as basal dressing, respectively.

As shown in Fig.1, the space for foliage development was limited by either clear plastic board or black board(hereafter, referred to as non-shaded plots and shaded plots, respectively) with six different shading angles(45° , 60° , 90° , 120° , 180° and control of 360°). The shading boards were 24 ×120cm vinyl chloride boards.

Plant length, the number of culms and top dry weight were measured for 10 plants in each plot at the panicle formation, heading and maturity. Grain yield was measured at maturity. Ripened grains were determined based on specific gravity using salted water(specific gravity over 1.10 is defined as ripened). Total nitrogen content was measured for each organ, using the method described in previously[5].

Results

Plant length in non-shaded plots at panicle formation stage decreased with increasing growing space for foliage development(Fig.2). The negretive

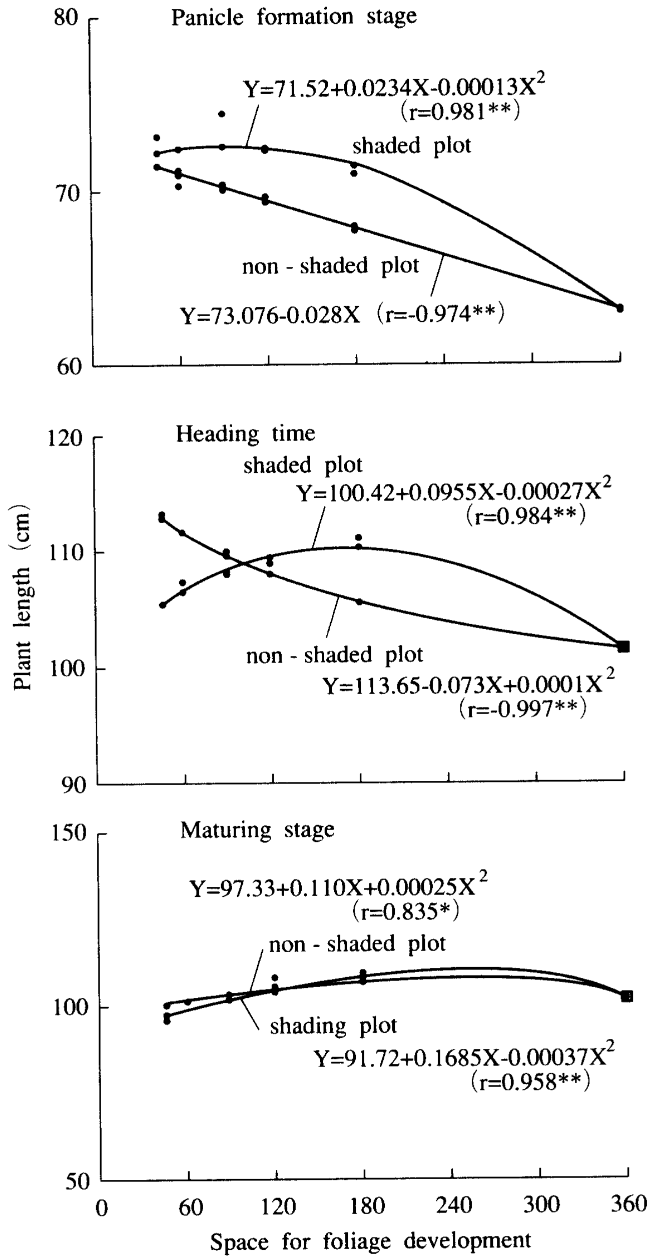

Fig. 2 . Relationship between plant length and space for foliage development.

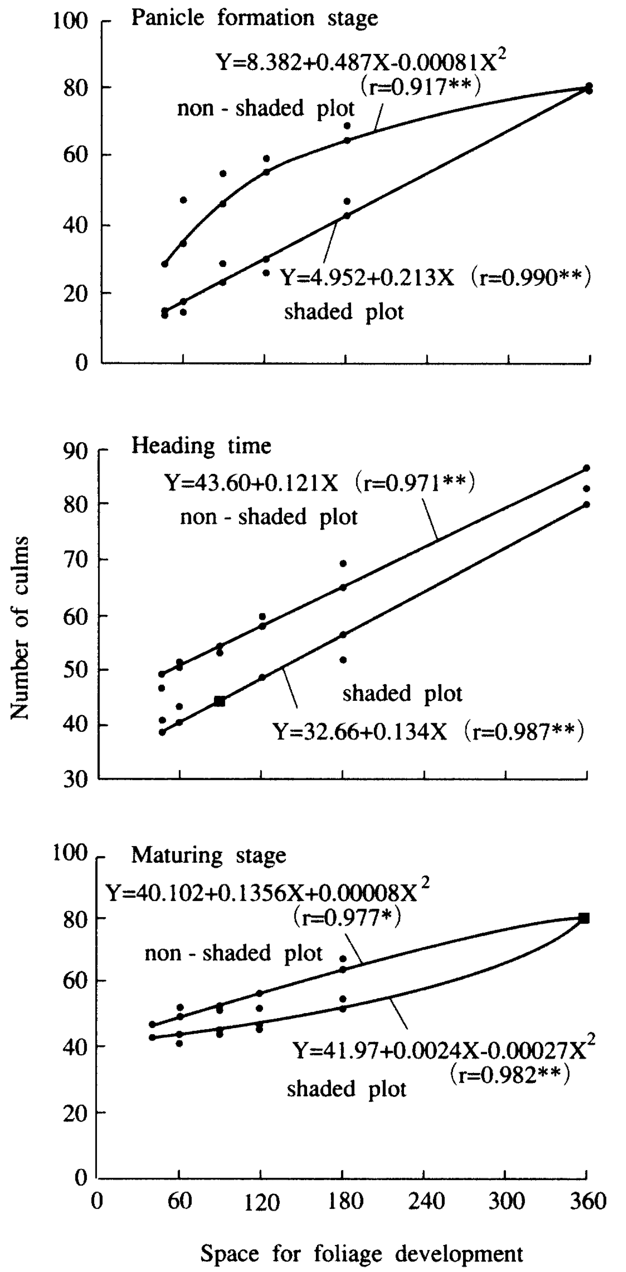

Fig. 3 . Relationship between the number of clums and space for foliage development.

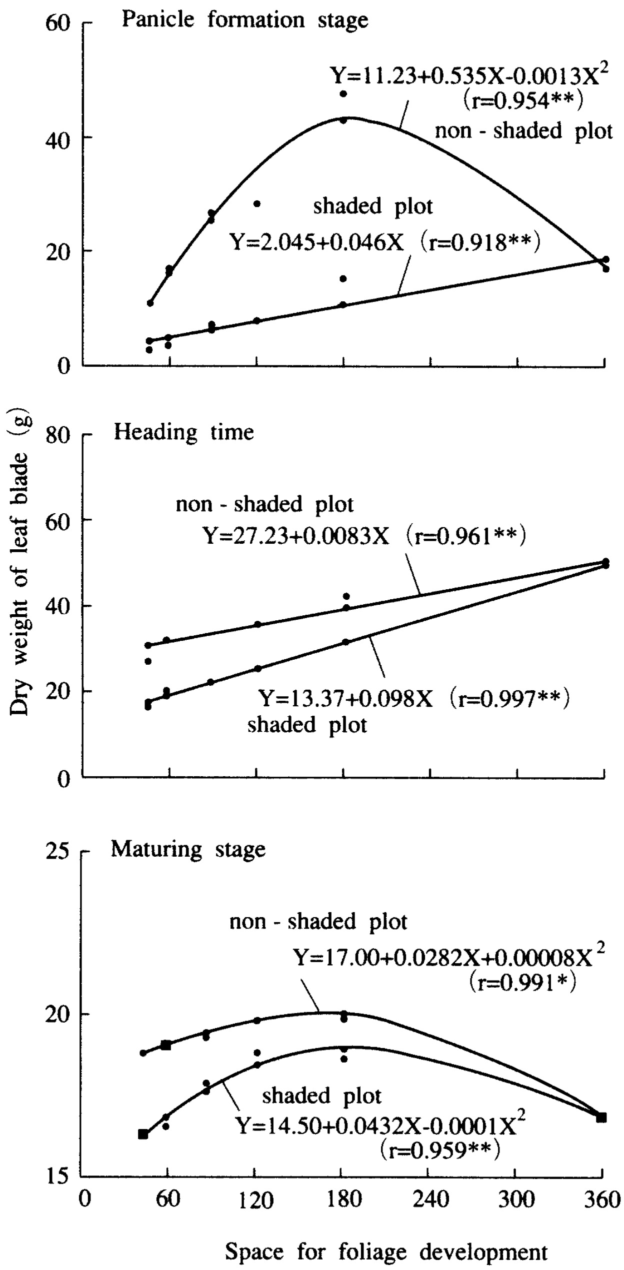

Fig. 4 . Dry weight of leaf blade under different space for foliage development.

correlation was highly significant.

Apparently limited space for foliage development promoted plant length. On the other hand, plant length in shaded plots also increased but not by as much as longer than that in non-shaded plots.

At heading time, plant length in non-shaded plots increased continuously with decreasing space, while in shaded plots plant length was greatest at 180° plot. At maturity plant length was not strongly influenced by either growing space or shaded.

The number of culms in the shaded plots increased linearly with increasing growing space(Fig.3). The non-shaded plots showed similar tends.

Dry weight of each organ increased with increasing growing space, as shown in Fig. 4 to 8, except in the follwing cases. The dry weights of leaf blades at panicle formation stage and maturity were maximized in the 180° plot(Fig. 4). The dry weight

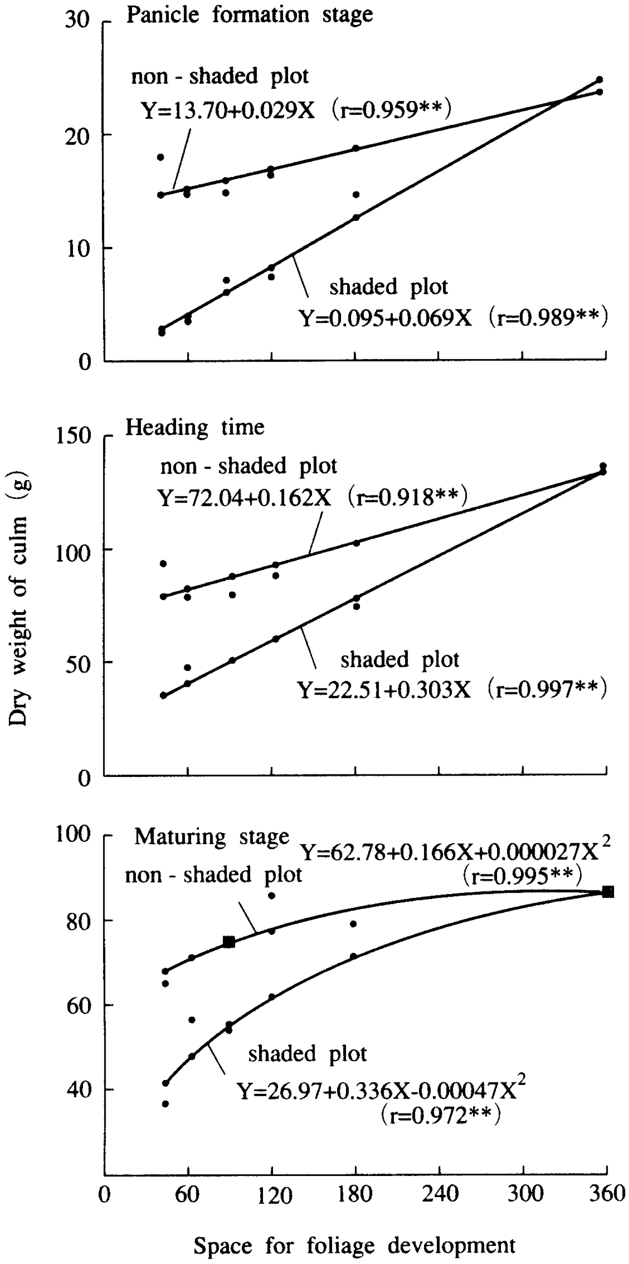

Fig. 5 . Dry weight of culm under different space for foliage development.

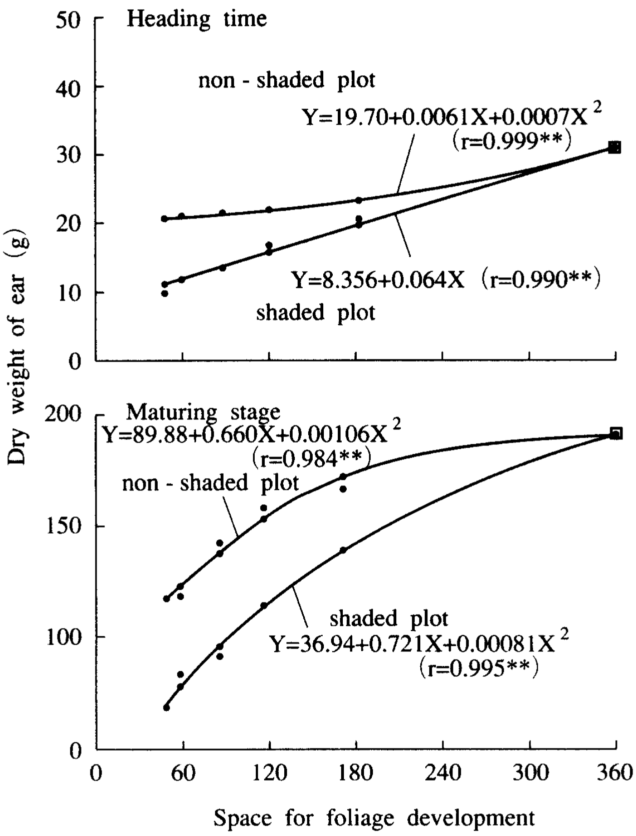

Fig. 6 . Dry weight of ear under different space for foliage development.

of dying organs at panicle formation stage was not influenced by growing space(Fig. 7). The regression curves were usually expressed by simple linear equations at heading time and by quadratic equations at panicle formation and maturity.

At panicle formation stage and heading time, the nitrogen content percentages of leaf blades and culms decreased with increasing growing space, expressed by linear equations, and were higher in shade plots than non-shaded plots. [However, the nitrogen content of culms in non-shaded plot at panicle formation stage was not influenced by growing space](Figs. 9 and 10). The nitrogen content percentage of ears was higher in shaded plots than non-shaded plots at heading stage, but at maturity, the reverse was true(Fig. 11).

The weight of ripened grains increased with increasing growing space, and was more strongly influenced by growing space in shaded plots than in non-shaded plots(Fig. 12).

Discussion

Clements[6] has described that competition in the plant community results from physical limits in the growing process. Intra-hill competition results from aboveground competition and underground competition. In this study, aboveground parts of rice plants were limited in either space or light under the same underground conditions, and some morphological characteristics were examined. The

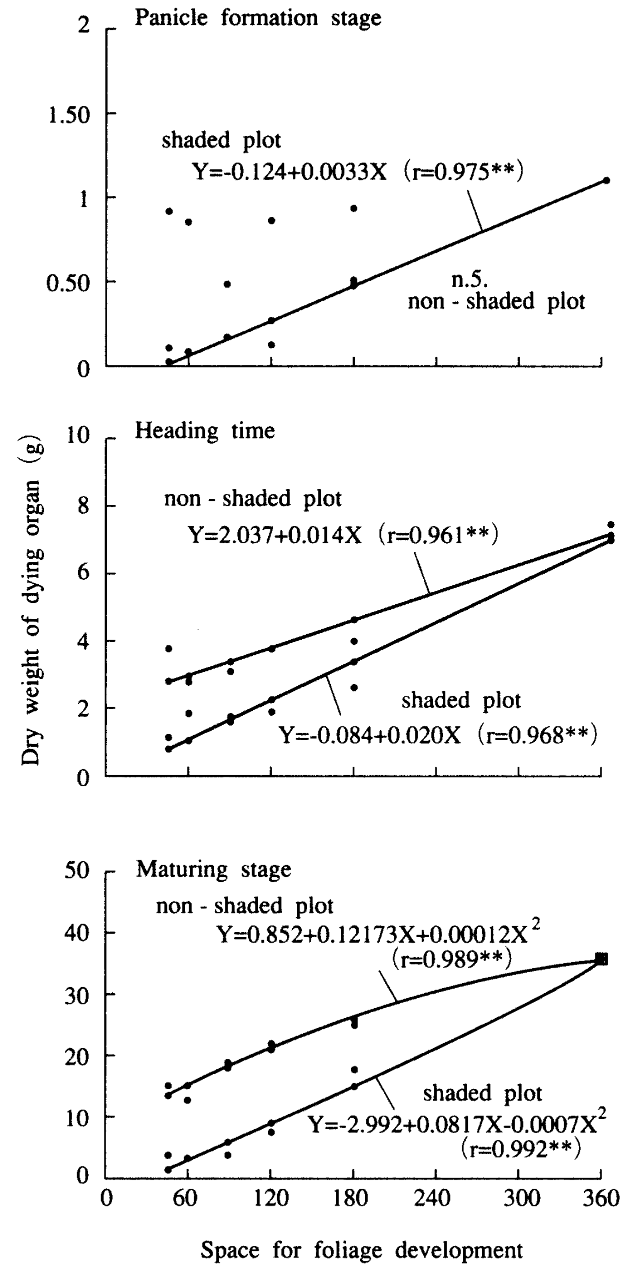

Fig. 7. Dry weight of dying organ under different space for foliage development.

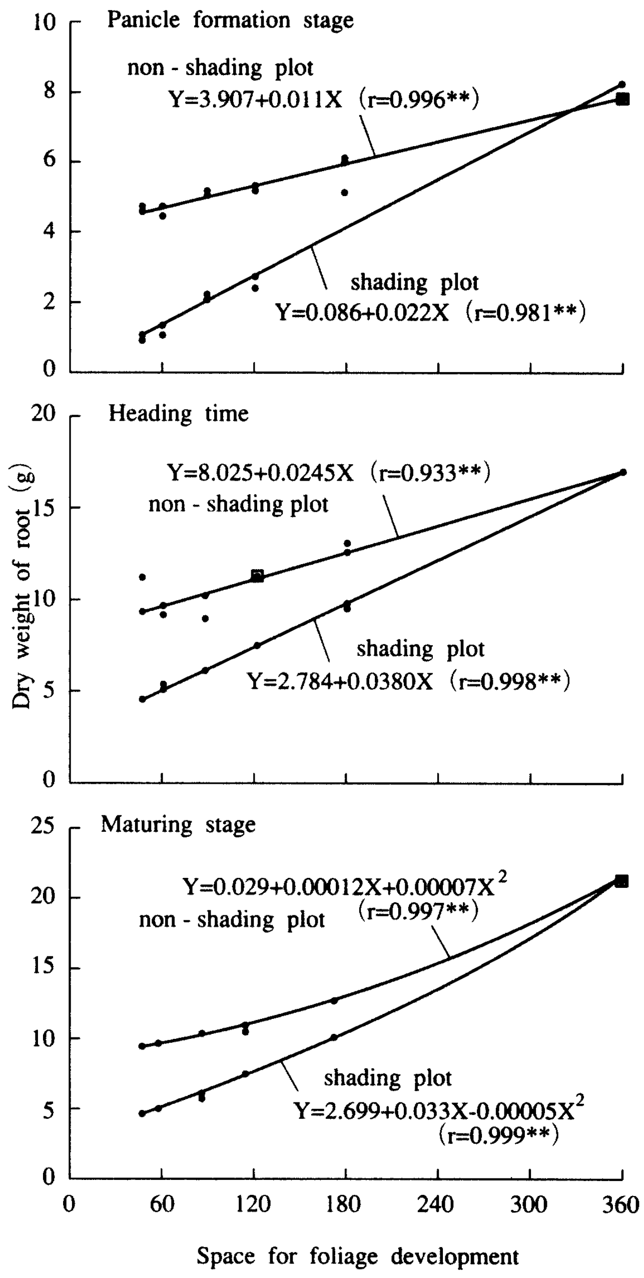

Fig. 8. Dry weight of root under different space for foliage development.

elongation of crown roots seemed to be inhibited by inserting shading boards into 3cm in depth. However, the seemed to elongate normally, based on visual observation at panicle formation stage.

The present results showed that plant length at panicle formation stage increased with decreasing space for foliage development. At heading time, shaded and non-shaded plots showed different growth rates which reversed at about 90° plot. At maturity stage, plant length of both shaded and non-shaded plots was not strongly influenced by limited growing space. Thus, it is likely that the increase in plant length is closely associated with a gain in the number of culms, or tillering.

Tillers in rice plants occur with extreme regularity[4]. In this experiment, rice seedlings were planted with odd numbered leaves on the side of the plastic board. Due to this planting, in the narrow growing

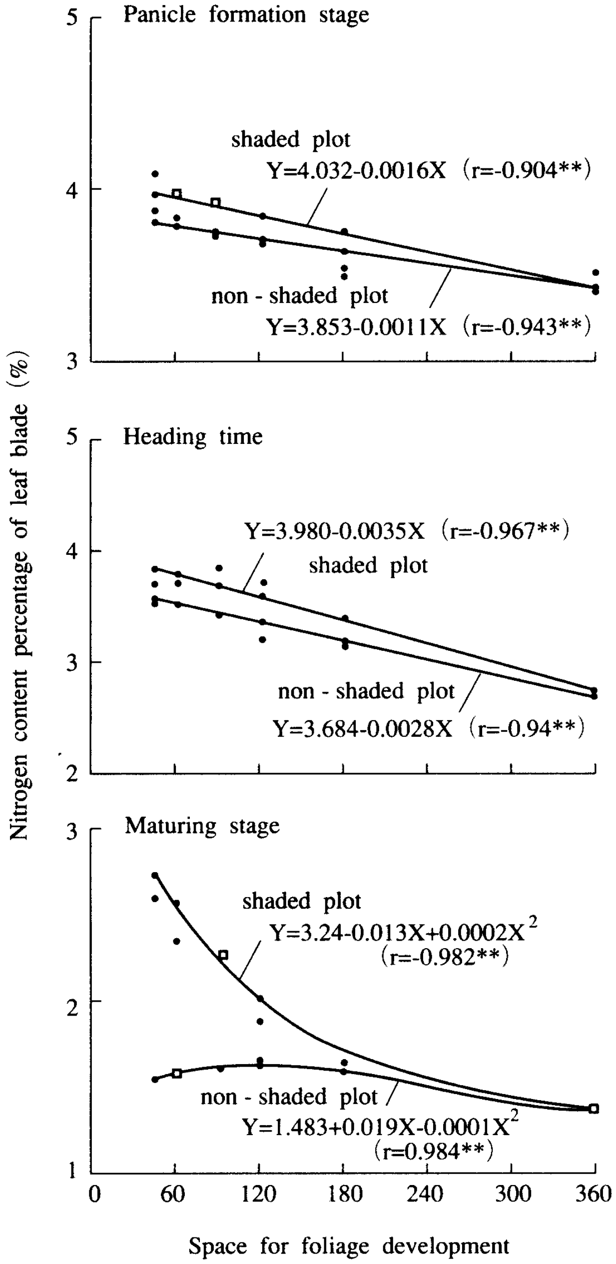

Fig. 9 . Relationship between nitrogen content of leaf blade and space for foliage development.

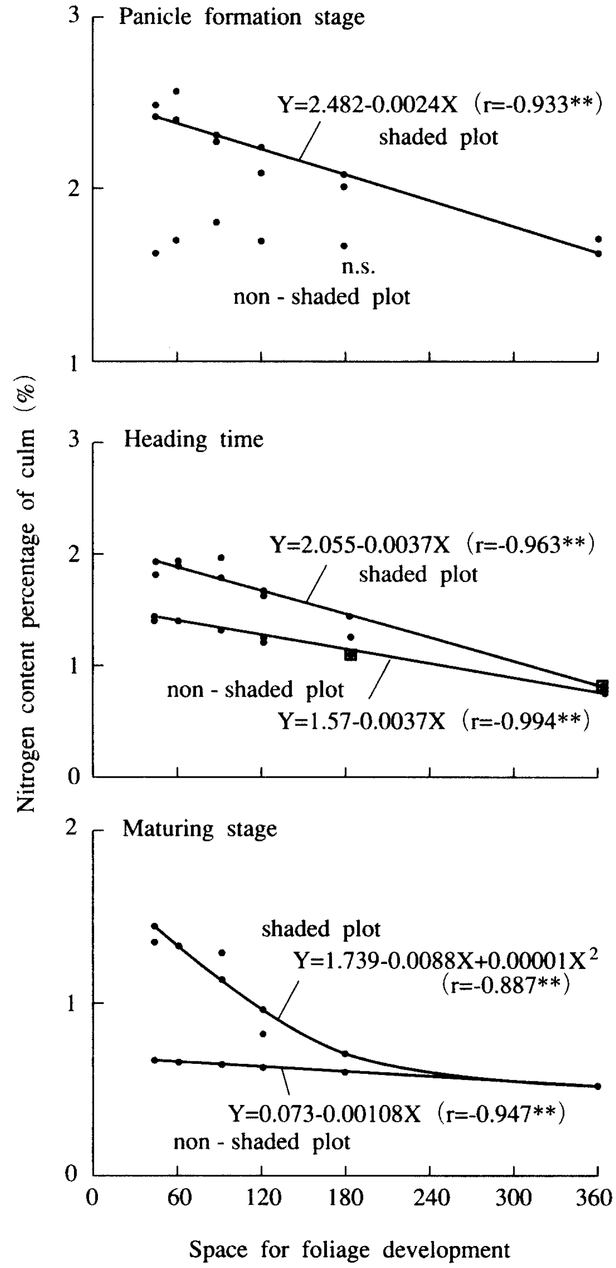

Fig.10. Relationship between nitrogen content of culm and space for foliage development.

space plots tillers arising from odd numbered leaves were arrested. On the other hand, in the wide space plots tillers were winding. In addition, fewer tillers were produced in shade plots than in non-shaded plots. Therefore, it is likely that development of tillers was controlled by light conditions[8].

The dry weight of leaf blades varied with the number of tillers. Effects of different growing spaces on the dry weight were expressed by quadratic equations for leaf blade in non-shaded plots at panicle formation stage and by linear eqations for leaf blade and culms in shaded plots at panicle formation stage and in both plots at heading time. This may indicate that the increase in dry weight, or growth amount, was resulted from the growth of each organ. At maturity, however, chaging dry weight of each organ(including ear) was shown by quadratic equations. Therefore, growth after heading probably var-

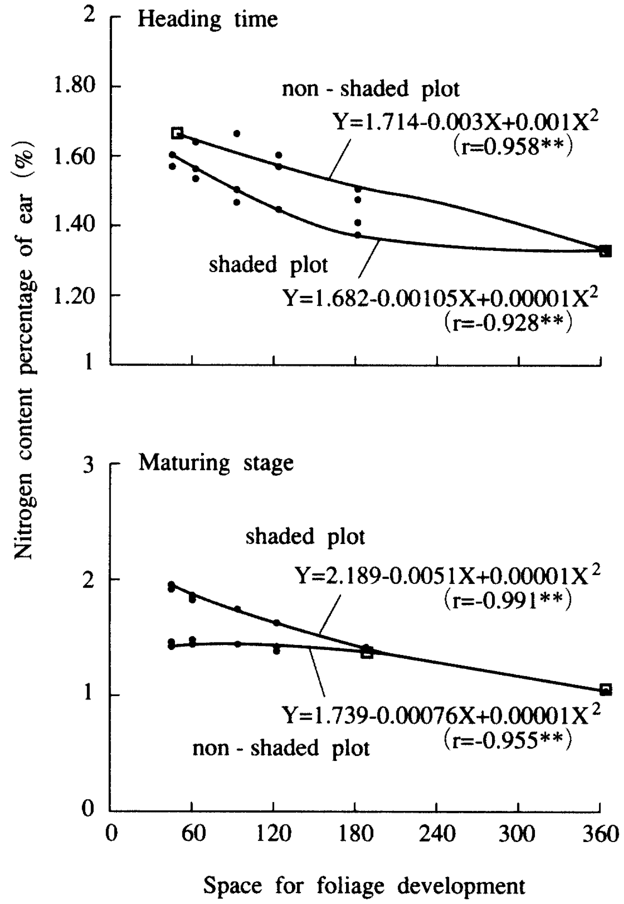

Fig.11. Relationship between nitrogen content of ear and space for foliage development.

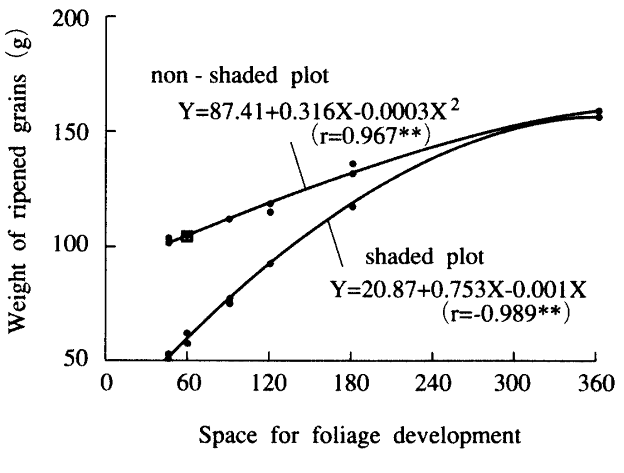

Fig.12. Relationship between weight of ripend graws and space for foliage development.

ied by translocation and accumulation of internal substances.

The nitrogen content percentage of leaf blade increased with decreasing growing space at panicle formation stage, and could be expressed by linear equations. Moreover, in each plot with different growing spaces, nitrogen content percentage in shaded plot was higher than in non-shaded plot. The nitrogen content percentage of culms showed a trend similar to that of leaf blades in the shaded plots, but in the non-shaded plots, a relationship between nitrogen content percentage and growing space was not observed. This indicates that the light conditions influenced nitrogen content percentage. At heading time, the nitrogen content percentage of leaf blade and culms decreased linearly with increaseing growing space, but in ear it was higher in shaded plots than in non-shaded plots. At maturity, nitrogen content of non-shaded plots was less influenced by limited growing space, while in shaded plots nitrogen content increased with decreasing growing space. Consequently, plants grown in shaded smaller growing spaces had a remarkable number of ears and the nitrogen translocated from foliage to ear, suggesting the involvement of a sink-source relation[8].

References

1) Akita, K. : *Sci. Rept, Fac, Agr. Kobe Univ.*, 12, 29-33, 1976.

2) Akita, K., Y. Ueyama and M. Tange : *Jpn. Jour. Crop Sci.*, *Extra issue*, 54(2), 22-23, 1985.

3) Akita, K., Y. Ueyama and M. Tange : *Jpn. Jour. Crop Sci.*, *Extra issue*, 54(2), 24-25, 1985.

4) Akita, K., and M. Tange : *Sci. Rept. Fac. Agr. Kobe Univ.*, 18, 23-26, 1988.

5) Akita, K., N. Tanaka and M. Tange : *Jpn. Jour. Crop Sci.*, 58(2), 186-191, 1989.

6) Clements, F. E. : *Plant succesion.* Caring Inst., Washington, Pub. pp. 242. 1916.

7) Kawata, S. and M. Katano : *Proc. Crop Sci. Soc.*, 45, 471-783, 1976.

8) Kumura, A. : *Jpn. Jour. Crop Sci.*, 24, 177-180, 1956.

9) Sato, T. and K. Shimizu : *Jpn. Jour. Crop Sci.* 27, 179-181, 1952.

水稲の茎葉展開角度の広さが諸形質に及ぼす影響

秋 田 謙 司・田 中 尚 道

要　　約

本研究は、水稲の株内競合と地上部相互作用との関係を解明するため、地下部を同一条件とし、透明塩ビ板と黒色塩ビ板で1株の本数に該当するよう茎葉の展開角度を制御して、個体の諸形質に及ぼす影響を追究した。

草丈は、幼穂形成期には角度が狭いほど伸長していたが、成熟期には角度制限による区間差は縮小していた。

茎数と制限角度との関係は角度が狭いほど少なく、また、仕切板が黒色の場合は仕切板が透明の場合より少なく、分げつの発育は光条件に影響されることが明らかとなった。

各器官の乾物量は茎数と密接な関係があるが、出穂期頃からは体内物質の転流・蓄積によって変動するものと考えられた。

葉身の窒素含有率は、幼穂形成期には角度が狭いと高く、同一角度では透明区の方が黒色区より高かった。茎でも、黒色区は葉身と同様の傾向を示したが、透明区では相関関係が認められず、光による影響が示唆された。しかし、出穂期の茎葉はいずれも一次式で示された。成熟期の各器官の窒素含有率は、黒色区では角度が狭いと高い値を示したが、透明区では区間差が小さかった。このことは、狭い角度の黒色区では穂数が著しく減少しており、茎葉から穂へ移行する窒素量が少なかった。これは、sink-sourceの関係によるものと考えられる。