粳秈稻再生節位之不同與氮肥之影響[1]

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摘　要

本試驗之主要目的是要研究水稻生長後期施用氮肥可以促進稻株產生再生芽之真正原因以及粳秈稻再生特性之差異，以供改進再生稻栽培技術之參考。試驗結果發現：(1)在黃熟期施用氮肥可以促進稻株之光合作用，使其繼續製造碳水化合物，以利於延緩稻株之老化並產生再生芽。(2)成熟期水稻劍葉之碳素和氮素含量以及碳氮比之高低爲該水稻收割後再生率高低之良好指標，碳素和氮素含量高而碳氮比低者再生力較強。(3)粳秈稻之再生節位次序完全相反，粳稻之再生芽是從接近地面之根部節位開始逐漸往上部之節位生長；秈稻之再生芽則從稻穗下面之第二節開始逐漸往下面之節位生長。由於粳秈稻之再生節位次序不同，粳秈稻之留椿高度也應不同，粳稻可以一次從接近地面之部位刈割也不致於將已經長出之再生芽全部割除，因而不但不會影響其再生力，更可節省再度刈椿之成本；秈稻於第一次刈割時應量高椿以免將已經長出之再生芽全部割除而影響其再生力，等下部節位長出再生芽後再刈割第二次。

前　言

根據一些學者之報告[1,2,4]水稻再生力之強弱是一種遺傳特性，品種間再生力之強弱差異很大，栽培再生稻之前必須選擇再生力較強之品種獲得成功之機會較大。可是環境因子對水稻再生力之影響也很大，如能善加控制利用，也可幫助提高再生力和產量；例如於前作之黃熟期和再生稻之生長初期適當地使用氮肥即可使水稻之再生率和產量顯著地提高[3,5]，但氮肥究竟如何促進水稻再生，其原因並不清楚。另一方面前作水稻收割時之留椿高度對再生率之影響也很大，但各學者之意見並不一致，Parageo和Prashar等主張前作必須齊地面收割[6,7,8]；Saran則認爲齊地面收割會使再生稻之產量降低[9]；蘇昌吉氏則主張前作收割時應留椿5－15公分，俟其再生後再刈椿一次，以提高其再生率並延長其營養生長期，即可獲得較高之產量[10]，雖然各學者之意見均有其試驗根據，但其原因迄今尚未明瞭。

本試驗之目的在研究於前作水稻黃熟期施用氮肥促使再生芽發生之生理原因，以及粳秈稻再生芽發生之差異性，以供改進再生稻栽培技術之參考

材料與方法

本試驗是在臺中區農業改良場大村新場舉行。第一作是採用移植栽培法種植於磁缽中，首先於缽中放置土壤15公斤並灌水至約半公分水深左右，施下基肥，用手將表土稍加攪勻之後即開始插秧。缽中使用之土壤屬於砂頁岩沖積土，質地爲砂質壤土，pH 5.5，EC 1.52 mmhos/cm，有機質1.46%，磷(Bray 1) 16 ppm；交換性陽離子，鉀26 ppm，鈉178 ppm，鈣580

[1] 臺灣省臺中區農業改良場研究報告第 0115 號。

[2] 分別爲臺中區農業改良場技正、助理、及約雇助理。

ppm，鎂27 ppm；可萃取性微量元素，鐵750 pm，錳6 ppm，鋅3.4 ppm，銅0.9 ppm。

水稻品種，粳稻採用臺中189號與臺農67號二種，籼稻採用臺中籼10號與臺中籼3號二種；插秧日期爲民國75年3月23日，每缽種植一欉，每欉6株。種植完畢後按照逢機完全區集法將同一重複之8處理集中放在一起，全部試驗四個重複。施肥量，磷酐90 ppm，用過磷酸鈣，全部當基肥於插秧前一天施下；氮肥用硫酸銨，於基肥時使用24 ppm，插秧後15，30及55天分別使用20，29及24 ppm；鉀肥用氯化鉀，於插秧後15及30天分別使用20及36 ppm氧化鉀。到6月24日水稻黃熟期開始按照下列方法處理：

1. V_1N_0：臺中189號，黃熟期不施任何氮肥。
2. V_2N_0：臺農67號，黃熟期不施任何氮肥。
3. V_3N_0：臺中籼10號，黃熟期不施任何氮肥。
4. V_4N_0：臺中籼3號，黃熟期不施任何氮肥。
5. V_1N_1：臺中189號，黃熟期施用25%氮肥。
6. V_2N_1：臺農67號，黃熟期施用25%氮肥。
7. V_3N_1：臺中籼10號，黃熟期施用25%氮肥。
8. V_4N_1：臺中籼3號，黃熟期施用25%氮肥。

到7月17日水稻成熟期，開始調查株高，每缽穗數，並採取劍葉和全株分析其碳素和氮素含量，然後分別採收稻穗，以調查其產量和產量構成因素，最後將稻株全部挖起，調查上下各節之再生芽數和再生芽長度。

結　果

從表1可以發現處理1與5，2與6，3與7，及4與8之株高，每缽穗數，每穗粒數、稔實率、千粒重、稻穀與稻草產量均沒有顯著之差異，表示於前作水稻之黃熟期增施25%氮肥與否對該期水稻之生長、產量及產量構成因素均未產生明顯之影響，但表2卻顯示施用氮肥處理5、6、7、8稻株劍葉之碳素和氮素含量均高於未施氮肥處理1、2、3、4，而碳氮比則剛好相反，未施氮肥處理高於施用氮肥之處理。此一結果暗示我們於前作水稻之黃熟期施用一次氮肥促進

表一　再生稻之前作水稻產量及產量構成因素

Table 1. The yield and yield coponents of the main crop of the ratoon rice[1)]

Treatments	Plant height cm	Panicle number per pot	Grain number per panicle	Filled grain %	1000 grain wt. g	Grain yield g/pot	Straw yield g/pot
1. V_1N_0[2)]	98	31	93	91.4	24.2	68.3	67.0
2. V_2N_0	96	34	87	89.1	24.5	65.9	65.1
3. V_3N_0	105	27	100	80.7	25.5	68.9	67.9
4. V_4N_0	90	32	104	82.7	25.4	84.3	83.2
5. V_1N_1	101	31	88	90.9	24.6	65.6	65.3
6. V_2N_1	97	31	85	88.4	24.4	64.0	62.7
7. V_3N_1	104	25	98	80.4	25.3	70.2	69.5
8. V_4N_1	89	37	100	82.9	25.7	85.3	84.4

1) The figures in the table are the average values of 4 pots.

2) V_1: Taichung 189, V_2: Tainung 67, V_3: Taichung sen 10, V_4: Taichung sen 3
No: No nitrogen fertilizer at the yellow maturing stage of the main crop, N_1: Topdressed 25% additional nitrogen fertilizer at the yellow maturing stage of the main crop.

表二　再生稻之前作水稻成熟期之含碳氮量

Table 2. The total carbon and nitrogen contents of the rice plants in the main crop of ratoon rice at maturing stage.

Treatments	Flag leaves			Whole plants		
	C%	N%	C/N	C%	N%	C/N
1. V_1N_0	37.4^{c*}	1.15^{bc*}	32.5	69.0	0.67	103.0
2. V_2N_0	38.2^{c}	0.95^{c}	40.2	62.4	0.51	122.4
3. V_3N_0	40.1^{bc}	0.63^{c}	63.6	68.6	0.55	124.7
4. V_4N_0	42.5^{bc}	0.48^{c}	88.5	70.1	0.35	200.3
5. V_1N_1	53.3^{a}	2.17^{a}	24.6	62.9	0.74	85.0
6. V_2N_1	58.2^{a}	1.59^{ab}	36.6	66.8	0.67	99.7
7. V_3N_1	49.5^{ab}	1.65^{ab}	30.0	66.9	0.84	79.6
8. V_4N_1	55.4^{a}	1.59^{ab}	34.8	64.5	0.71	90.9

* Significantly different at 5% level by Duncan's multiple range test.

了稻株之光合作用，使其繼續製造碳水化合物，因而延緩了稻株之老化並提高其再生力，未施氮肥者因無法繼續製造碳水化合物，而急速老化枯死。成熟期水稻劍葉之碳素、氮素和碳氮比之高低可做爲該期作水稻收割後再生率高低之指標，經分析結果顯示碳素含量大於50%，氮素含量大於1.5%，而碳氮比在36以下者收割後再生力都相當強。從稻株之外表（圖5、6）也可以看到施用氮肥與未施用氮肥處理稻株間之差異，施用氮肥處理之稻株呈綠色，粳稻於靠近地面根部之節位首先產生再生芽，然後逐漸向上部之節位產生，秈稻則多數從穗下第二節開始產生再生芽，然後逐漸向下部之節位產生；未施氮肥處理之稻株則呈黃化枯照現象，極少再生芽或完全沒有再生芽。

從表3和圖2可以發現，於前作水稻之黃熟期施用氮肥之處理5、6、7、8無論任何品種和節位之再生芽數都多於未施氮肥之處理，但無論施用氮肥與否，粳稻之再生芽數都較秈稻爲多，尤其是未施氮肥之處理1和2之粳稻仍有少數之再生芽，而處理3、4之秈稻則完全沒有再生芽，可能是秈稻需要較多之氮肥才能維持正常光合作用功能之緣故。另一方面，粳稻以接近地面根部節位之再生芽數最多，愈上部之節位再生芽數愈少；秈稻則剛好相反，接近地面

表三　再生稻不同節位之再生芽數

Table 3. The number of ratoon tiller from different nodes (tillers/pot).[1)]

Treatments	Ground node	Second node above ground	Third node above ground	Fourth node above ground (ususaly the 2nd node from the top)
1. V_1N_0[2)]	0.8	2.0	0.3	0
2. V_2N_0	8.8	3.3	0.3	0
3. V_3N_0	0	0	0	0
4. V_4N_0	0	0	0	0
5. V_1N_1	12.3	18.0	6.3	0.3
6. V_2N_1	16.5	12.0	1.0	0
7. V_3N_1	1.3	2.3	2.5	4.3
8. V_4N_1	5.8	8.5	9.5	9.5

1) and 2): The same as table 1.

根部節位之再生芽數最少，愈上部之節位再生芽數愈多，而以稻穗下部第二節之再生芽數最多（表3及圖1）

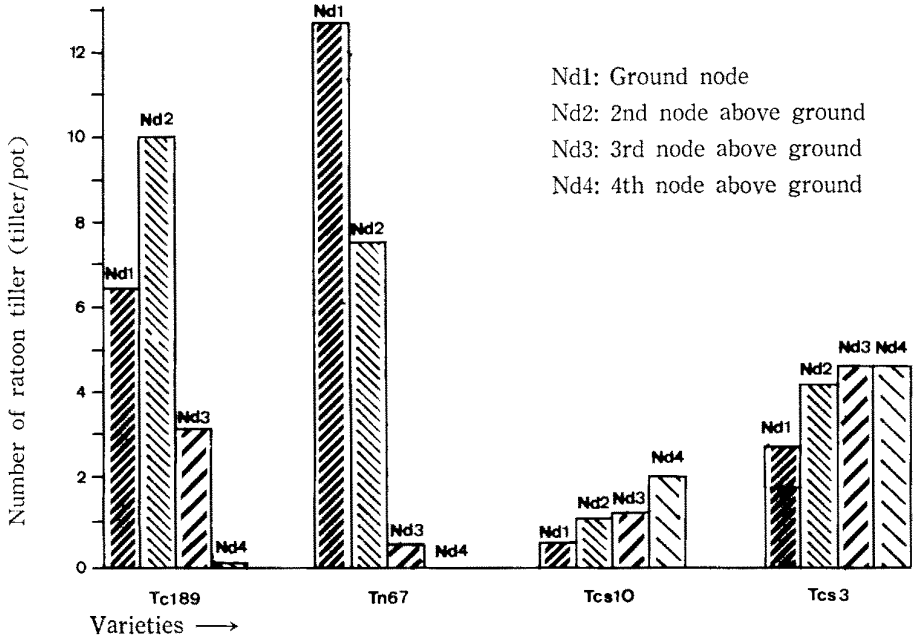
表4及圖4則顯示黃熟期施用氮肥之處理5、6、7、8之再生芽長度都較未施氮肥處理之再生芽長，但無論施用氮肥與否，粳稻之再生芽都較籼稻之再生芽長，而未施氮肥之處理粳稻仍有少數短小之再生芽，籼稻則完全長不出再生芽，其理由與再生芽數相同，籼稻需要較多之氮肥以維持正常光合作用之功能。從再生芽長度方面也可以發現粳籼稻再生特性之不同，粳稻以接近地面根部節位之再生芽最長，愈上部節位之再生芽愈短，籼稻則剛好相反，接近地面根部節位之再生芽最短，愈上部節位之再生芽愈長，而以稻穗下部第二節之再生芽最長（表4，圖3和7）。根據這些資料可以證明粳稻之再生芽是從接近地面根部之節位開始而逐漸向上部節位長出，籼稻之再生芽則從穗下第二節開始而逐漸向下部之節位長出。此一粳籼稻再生特性之差異，指示我們粳稻收割時，不必留高樁可以一次切割至接近地面附近，因爲它的再生芽多數在近地面有根部之節位；籼稻收割時則應先留高樁以便保留一部分上部節位已經長出之再生芽，等下部節位之再生芽長出後再切割一次，即可提高其再生率。

表四　再生稻不同之再生芽長度

Table 4. The length (cm) of ratoon tiller from different nodes.[1)]

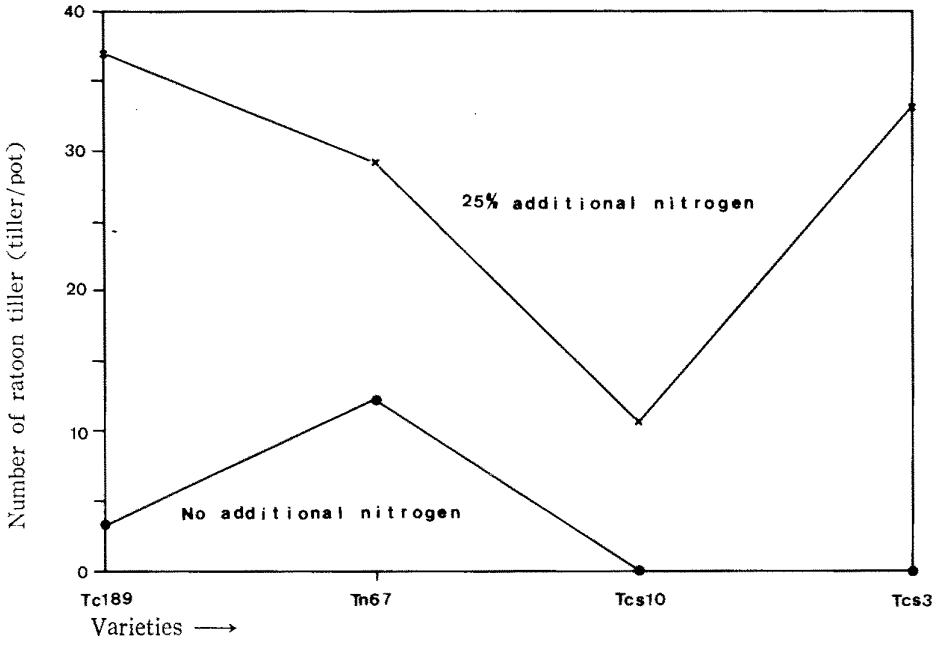
Treatments	Ground node	Second node above ground	Third node above ground	Fourth node above ground (ususaly the 2nd node from the top)
1. V_1N_0[2)]	0.5	2.9	1.8	0
2. V_2N_0	3.5	2.6	0.6	0
3. V_3N_0	0	0	0	0
4. V_4N_0	0	0	0	0
5. V_1N_1	10.4	9.4	4.3	0.9
6. V_2N_1	9.6	7.5	5.8	0
7. V_3N_1	4.0	4.1	4.3	7.9
8. V_4N_1	8.5	7.6	8.7	20.0

1) and 2): The same as table 1.



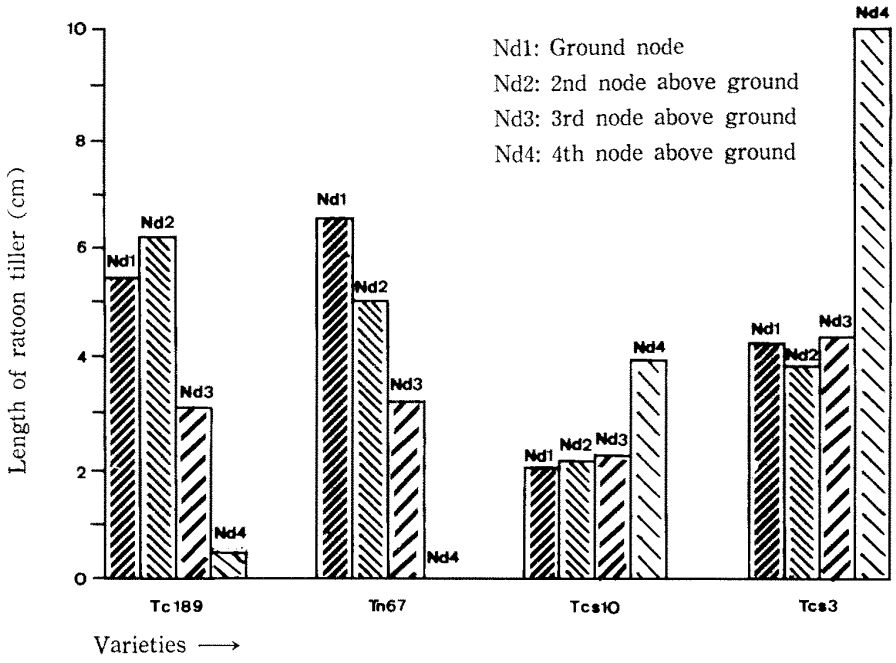
圖一　各種不同水稻品種各節位之再生芽數

Fig 1. The number of the ratoon tillers from the different nodes of the different varieties of rice.



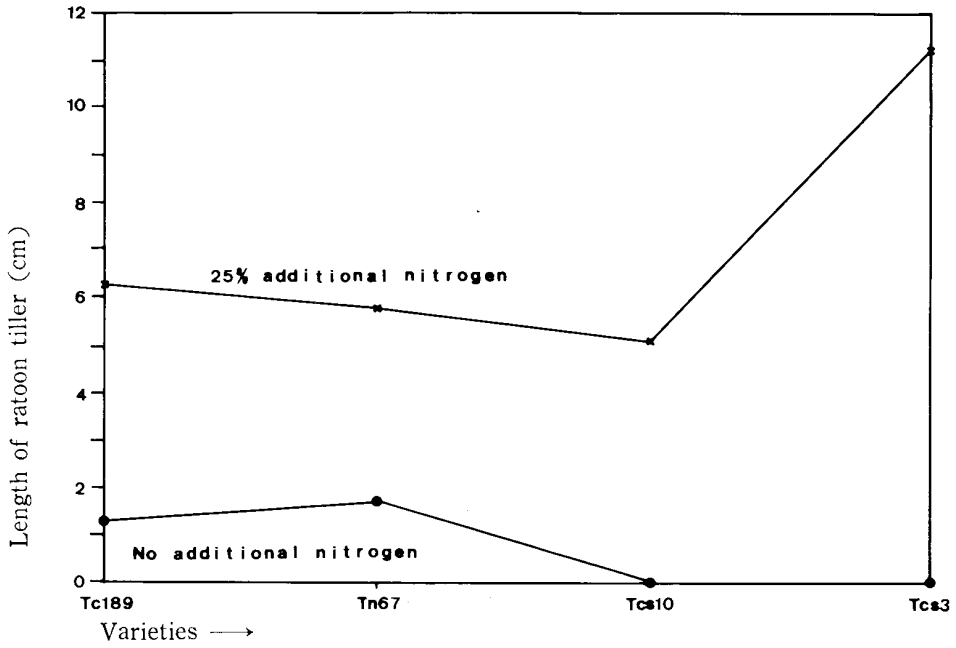
圖二　氮肥對各種不同水稻品種再生芽數之影響

Fig 2. The effect of nitrogen fertilizer on the ratoon tiller number of the different varieties of rice.



圖三　各種不同水稻品種各節位之再生芽長度

Fig 3. The length of the ratoon tillers from the different nodes of the different varieties of rice.



圖四　氮肥對各種不同水稻品種再生芽長度之影響

Fig 4. The effect of nitrogen fertilizer on the average length of the ratoon tiller of the different varieties of rice.



圖五　黃熟期增施 25%氮肥之粳稻臺農 67 號和臺中 189 號之植株呈綠色並於基部長出許多再生芽(左)，未施氮肥者植株黃化，基部也很少再生芽(右)

Fig 5. Japonica rice plants (Tainung 67 and Taichung 189) topdressed with 25% nitrogen at yellow maturing stage were greener with many ratoon tillers on the nodes in the rooting area (left) and those without nitrogen topdressing were chlorotic with very few ratoon tiller on the nodes in the rooting area (right).



圖六　黃熟期增施 25%氮肥之秈稻臺中秈 3 號和 10 號之植株呈綠色，上部節位長出許多較長之再生芽(左)，未施氮肥者植株嚴重黃化或枯死，上下各節位均未長出再生芽(右)。

Fig 6. Indica rice plants (Taichung sen 3 and 10) topdressed with 25% nitrogen at yellow maturing stage were greener with many longer ratoon tillers on the upper nodes (left) and those without nitrogen topdressing were seriously chlorotic or without any ratoon tillers on all nodes (right).



圖七　籼稻(左)之再生芽是從稻穗下面第二節逐漸向下部之節位長出，而粳稻(右)之再生芽是從接近地面根部之節位逐漸條部之節位長出

Fig 7. The ratoon tiller of indica rice first appeared on the 2nd node from the top and then to the lower nodes (left), and those of japonica rice first appeared on the node near the ground and then to the upper nodes (right).

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The difference in the order of ratooning node between Japonica and Indica rice and the effect of nitrogen fertilizer[1]

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ABSTRACT

The ojectives of this experiment is to study the reason why application of nitrogen fertilizer at the late stage of rice growth promoted the growth of rice tiller, and the difference in the ratooning character between Japonica and Indica rice, for improvement of the cultural technique of ratoon rice. The results of the expreiment are summarized as follows:

(1) Application of nitrogen fertilizer at the yellow maturing stage promoted the function of the phyotosynthesis of rice plants for the continuous production of carbohydrates, and thus delayed the incidence of the senescence of rice plants and stimulated the growth of ratoon tiller.

(2) The contents of total carbon and nitrogen, and the ratio of carbon/nitrogen in the flag leaves of rice plants at matuing stage are the good indicators for predicting the ratooning ability of rice plants after harvest. The rice plants with higher total carbon and nitrogen, and lower carbon/nitrogen ratio showed higher ratooning ability.

(3) Japonica and Indica rice are completely reverse in the order of ratooning nodes. The ratoon tillers of Japonica rice first appeared on the nodes in the rooting area near the ground, and then gradually to the upper nodes; and those of Indica rice first apeared on the second node under the panicle (usually the fouth node above the ground) and then gradually to the lower nodes. This difference in the order of ratooning nodes suggested that Japonica and Indica rice should keep different stubble length at harvest time for ratooning. Japonica rice may be cut to the part near the gournd without any worry to cut off too many germinated ratoon tillers to affect the ratooning rate; and Indica rice should keep high stubble at the first cutting to avoid cutting off too many germinated ratoon tillers on the upper nodes and conduct the second cutting after the appearnce of adequate ratoon tillers on the lower nodes.

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