YIELD DECREASE OF CORN SOWN INTO ITALIAN RYEGRASS BY MINIMUM TILLAGE

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ABSTRACT
The objective of this study was to determine the factor causing yield decrease of corn (*Zea mays* L.) sown into Italian ryegrass (*Lolium multiflorum Lam*.) by minimum tillage. 5 plots with 2 replications were made, consisting of the number of harvest times of Italian ryegrass, tillage system, and herbicide application. They were 1CT (Italian ryegrass was harvested once/conventional tillage), 1MT (once/minimum tillage), 1MTH (once/MT/herbicide), 2CT (twice/CT), and 2MT (twice/MT). 1MT produced lowest corn yield and highest Italian ryegrass litter. This observation suggested that corn yield decrease was attributed to competition with Italian ryegrass regrowth. NAR in 1MT after 5 leaf stage indicated considerable decline in comparison with the others. Relative light intensity was under 5% in 1MT, in which the corn couldn't grow. There was no certain trend between plots in soil property. From these results, it was concluded that shading caused by Italian ryegrass was the main factor of yield decrease of corn in minimum tillage.

KEYWORDS
minimum tillage, corn, Italian ryegrass, yield decrease, competition, shading

INTRODUCTION
Although the climate of Kyushu island in southwest Japan is favorable, most dairy farmers have little space for forage crops. Therefore they try intensive cropping systems (e.g. Italian ryegrass-corn-corn/year). Minimum tillage will be very effective to save labor, time, and energy for land preparation in these cases. The authors have been studying minimum tillage for corn into Italian ryegrass, but so far corn yield is not high especially without herbicide (Kobayashi et.al., 1995). It is probably due to competition with Italian ryegrass regrowth. But the yield decrease factors which have been proposed in general are: 1) low crop density by poor germination; 2) competition with weeds; 3) decline of soil temperature, etc. (Sakai,1988). In this study, the detailed factor of corn yield decrease under the competition was investigated.

MATERIALS AND METHODS
The field study was conducted in 1994 and 1995 at the Kyushu National Agriculture Experiment Station in Japan. The study area was plowed followed by a pass of rotary harrow, bedded, and Italian ryegrass (IR) was planted last fall . The IR was harvested twice in the next April and May. Five plots with 2 replications were made at the start of the corn growing season, consisting of the number of IR harvest times, tillage system, and herbicide application. The numbers of IR harvest times treatment were once (in April) and twice (in April and May). They mean the difference of temperature at seeding. Tillage treatment were conventional tillage (CT) and minimum tillage (MT). Herbicide treatment was herbicide application or without it. These were 1CT (IR was harvested once/CT), 1MT (once/MT), 1MTH (once/MT/herbicide), 2CT (twice/CT), and 2MT (twice/MT).

Conventional tillage plots were tilled with a rotary harrow to a depth of 15 cm after 1st and 2nd IR harvest with manure and granular fertilizer. Manure and fertilizer N rates were 2t/10a and 10kg/10a, respectively in both years.

In minimum tillage plots, the soil was strip tilled so that corn seed could be seeded directly after 1st or 2nd IR harvest. The soil disturbance was 25-30cm in width and 5-10cm in depth. The device used was a cultivator and corn planter. Granular fertilizer was surface banded along the crop row at seeding. The N rates were 3kg/10a in 1994, 8kg/10a in 1995.

Corn was seeded into all plots at a rate of 6670 plants/10a with 0.75-m row interval. The corn cultivar used was Pioneer 3352. In 1MTH, nicosulfuron was applied 4g/10a (active ingredient) at 4 leaf stage of corn. All plots were top dressed at the 5 leaf stage of corn in both years. Slurry at rate of 6t/10a and granular fertilizer of 5kg N/10a were applied to MT and CT plots, respectively in 1994. MT and CT plots received 7kg N/10a and 5kg N/10a as granular fertilizer, respectively in 1995.

Growth analysis was performed in 1995. Ten corn plants per plot were sampled for DM and leaf area estimation at the 5, 8, 12 leaf stage, and IR was also sampled at a time. Corn plants and IR litter samples were taken at yellow ripe stage of corn, and analyzed for N concentration in 1995. The samples were oven-dried at 70°C for 72 hours, weighed, and analyzed total-N by Kjeldahl procedure.

Soil property was investigated in 1995. Soil cores were taken to a depth of 15cm to determine pH (H_2O) and total-N concentration after corn harvest. Four samples per plot were collected at random with 75 mm diam core. Soil total-N concentration data was obtained by dry combustion method (vario EL elemental analyzer). Bulk density was investigated to a depth of 15cm.

RESULTS AND DISCUSSION
The corn growing season of 1994 was hotter and had less precipitation than average years; in contrast, that of 1995 was cool and wet. The accumulative temperature and precipitation of the 1994 corn growing season (April to August) were 3580°C and 624 mm, respectively. The corresponding numbers for 1995 were 3335°C and 1190 mm. Accumulative temperature (°C) of 30 days after seeding, which may strongly affect the vigor of IR regrowth, were 572 (once IR harvest:1994), 620 (twice: 1994), 469 (once: 1995), and 604 (twice: 1995).

IR litter in MT plots in 1995 tended to be at a higher level than in 1994, and IR litter in 1MT was higher than 2MT. Corn DM yield showed a reverse trend on the whole (Table 1). These showed that cool climatic condition in spring enhanced IR regrowth as opposed to corn seedling. In once IR harvest plots, the corn DM yield was lowest in 1MT which had highest IR litter in both years. These observation suggests that there were some competition between corn and IR in light or nutrient. In other words corn growth was regulated by IR regrowth or litter amount, which was affected by temperature at corn seeding.

There was variance in above ground (corn + IR litter) N uptake (Table 1). This result means that N was left in the soil without corn' s uptake even after death of IR in 1MT, and suggests that the corn seedling suffered certain serious damage from competition with IR in 1MT, so that corn couldn't recover normal growth.

From these results, the growth analysis focused on corn early growth was carried out to determine the competition effect on corn growth and yield. While there was little difference in CGR among twice

harvest plots, there was variance among once harvest plots (Fig.1). General trend of CGR is controlled by LAI in early growth stage. But in this result NAR varied with the plots very widely even at 5-8 leaf stage and 8-12 leaf stage, and was lowest in 1MT (Fig.1). This suggests that CGR was influenced by NAR as well as LAI in minimum tillage. The relative light intensity at the ground level in 1MT was lowest (Table 1). Considering these facts, the main factor of decrease of corn growth and yield may be shading caused by IR regrowth.

Soil property was indicated in table 1. There were no certain trend in bulk density and pH. They were not regarded as main factor which affect corn growth. Total N concentration in 1MT and 2MT were higher than 1CT and 2CT, respectively. This implies that more N nutrient was left in MT plots than the others. These results confirm the hypothesis that the main factor is the shading.

Table 1
Dry matter, N uptake, and information about light and soil condition.

	DM(kg/10a)				N-uptake		relative light*	soil property		
	1994		1995		(kg/10a)		intensity	bulk	pH	total-N
	corn	IR	corn	IR	corn	IR	(%)	density		(%)
ICT	1566	73	1456	26	20.1	0.7	55.0	0.686	5.06	0.553
IMT	907	223	438	388	5.4	8.0	4.4	0.688	4.91	0.570
IMTH	1173	54	1487	114	19.4	2.4	49.0		5.03	0.525
2CT	1713	155	1174	0	14.0	0.0	64.5	0.627	4.75	0.524
2MT	1439	112	1227	257	12.8	3.5	17.4	0.677	4.90	0.546

* Measured on 2nd July (1CT, 1MT, 1 MTH), 27th July (2CT, 2MT) as phtosynthetic effective radiation at ground level in 1995.

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Figure 1
CGR and NAR change in corn early growth.