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Seed Growth, Yield and Nitrogen Distribution in Various Plant Components of Soybean Variety S.J.4 as Affected by Different Levels of Nitrogen Fertilizer.

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ABSTRACT

The study on seed growth, yield, and nitrogen distribution in various plant components of soybean variety S.J.4 as affected by different levels of nitrogen fertilizer was conducted at Kasetsart University, Kamphangsaen Campus between October 1984 to August 1985. Four nitrogen treatments consisted of 0, 20, 40 and 60 kg N/rai in the form of $(NH_4)_2SO_4$ were applied to the soil prior to planting soybean. The experimental design was randomized complete block with four replications.

The yield of soybean increased markedly in the plot receiving 60 kg N/rai. The number of pod per plant which is an index of seed numbers per area also increased significantly when receiving this particular level of nitrogen fertilizer. The number of seed per pod and seed size were not affected by nitrogen treatments.

Eventhough the duration of effective seed filling was prolonged only with an application of nitrogen at high rate (60) kg N/rai), days to maturity were remarkedly prolong with increasing rate of nitrogen application. However, the rate of seed filling period was not affected by nitrogen treatments. Regarding nitrogen distribution in various plant parts, it was found that nitrogenous compounds were generally translocated from the vegetative parts and pod wall to seed during seed filling period of soybean.

INTRODUCTION

The growth of soybean during the period in which dryweight accumulation in seed occur is important and related to the yield. The rate and duration of seed filling are the main factors controlling seed size (Daynard *et al.*, 1971 ; Egli, 1975; Hanway and Weber, 1971). Since seed size of soybean is one of the important yield components, hence the rate and duration of seed filling are directly related and could determine the yield of soybean.

Seed growth rate is related to the ability of the crop to photosynthesize so that assimilate will directly transfer from leaves to seeds. Seed growth rate is also related to the ability of crop to translocate storage carbohydrate from stem, root and various vegetative organs to seeds. In corn, Duncan *et al.* (1965) found that the daily rate of growth of individual corn kernel was relatively insensitive to short term fluctuations in the environment. They concluded that storage carbohydrates served as a buffer between carbon fixation and the accumulation of dryweight in the kernel.

Nitrogen is one of the essential elements required for soybean. Although nitrogen fixation process can supply nitrogen to this particular crop, researchers in the past had demonstrated that nitrogen from N fixation sources was not adequate for seed growth requirement. Hammon *et al.* (1951); Hanway and Weber (1971); Egli *et al.* (1978) reported that during the seed growth period, 50-64% of nitrogen required by seeds had to be supplied by vegetative part such as

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leaves and stems. Thibodeau and Jaworski (1975) confirmed that during the effective filling period of soybean seed, both nitrogen fixation and nitrate reduction processes were no longer active and the plant has to satisfy the nitrogen requirement of seed by translocating nitrogen from leaves and stems. Loss of nitrogen form the vegetative parts earlier than usual would cause early senescence of leaves, and therefore the seed size and yield would also decreases (Sinclair and de Wit, 1975).

The following experiment was conducted to study the importance of nitrogen and how it is related to the growth rate of individual soybean seed and grain yield.

MATERIALS AND METHODS

The experiment was conducted in October 1984 at Kasetsart University, Kamphangsaen Campus, Nakhonpathom, Thailand. Field trial and laboratory analysis were carried out from October 1984-August 1985. Soybean variety S.J.4 was used in this study. The trial was planted in the silty clay loam soil. Irrigation was given as needed throughout the growing season to maintain adequate moisture.

Soybean was planted in a well prepared seed bed done by throughly ploughed and harrowed the land twice for the benefit of controlling weeds. Seeds were planted in rows of 60 cm. apart. Within rows, the distance between hills of 20 cm. was employed. 3-5 seeds were dropped in each hill. Thinning the plant to one plant per hill was done after emergence.

The experimental design used was randomized complete block design with 4 replications. Total experimental plot was 35.5 x 36 m^2. Each of small sixteen individual plots had 7 x 6 m^2. in dimension. The following treatments were assigned to the plots accordingly

1. No nitrogen fertilizer given, control plot.
2. Application of nitrogen fertilizer at the rate of 20 kg N/rai.
3. Application of nitrogen fertilizer at the rate of 40 kg N/rai.
4. Application of nitrogen fertilizer at the rate of 60 Kg N/rai.

All nitrogen fertilizer treatments were given in the form of $(NH_4)_2SO_4$ by broadcasting in the plot after ploughing and followed immediately by harrowing. All seeds were innoculated with *Rhizobium japonicum* by mixing seed with the innoculum throughly.

Four plants were sampled from each plot every 7 day interval until maturity. The first sampling date began 23 days after emergence. Total dry weights of plant parts were obtained at each sample. After weighting, the samples of plant components were ground and sent to the laboratory for total nitrogen analysis using auto analyzer.

In order to obtain the rate and duration of seed filling period, four separate samples were harvested every three days interval. At each sampling date, pods were collected in paper bags and oven dried at 70°C for 72 hours. Seed weights were obtained by threshing the dried pods by hands, and counting and weighing the seeds. Final sampling for seed growth was also used for yield component determination. Grain yield was measured by harvesting 30 plants from a uniform stand and threshing with a small plot thresher.

The regression analysis was used to calculate the rate and duration of seed dry matter accumulation, using a method described by Daynard, Tanner and Duncan (1971) and Johnson and Tanner (1972). The slope represented the rate of seed filling and was calculated for the period when seed dry matter accumulation was approximately linear. The regression line was extrapolated to the zero-and maximum seed weight levels. The duration between these two points were considered as its "effective seed filling period" or EFP. A lag period (LP) was the period from flowering to the zero-yield point on the regression line.

RESULT AND DISCUSSION

I. Yield and yield components of soybean

Table I showed the yield per unit area (kg/rai) of soybean variety S.J.4 as affected by nitrogen fertilizer. Table II showed the yield components of soybean in this study.

It was found that yield per area of soybean increased slightly but not significantly when nitrogen fertilizer were given to plost from 0-60 kg N/rai. Among the three important yield components, the number of pod per plant increased as nitrogen fertilizer increased. At 60 kg N/rai, 104 pods were produced per plant which was significantly higher than those of control ($P < 0.05$). However, as it was also found in previous study (Pookpakdi, 1977), the number of seed and seed size in this study were not differed from one another when receiving different amount of nitrogen fertilizer. The result suggested that beneficial effect of nitrogen fertilizer on soybean grain yield was obtained only at a high rate of application. Furthermore, a variation of soybean yield was attribute mainly from numbers of seed per area rather than seed size.

Table I Yield per area (kg/rai) of S.J.4 soybean when received different amount of nitrogen fertilizer in the form of $(NH_4)_2SO_4$.

Fertilizer level (N. kg/rai)	Yield (Kg/rai)
0	138.4
20	156.2
40	172.8
60	191.0
X̄	164.7
LSD 0.05	—
C.V (%)	11.4

II. Rate and duration of seed filling period and days to maturity

Data on rate and duration of seed filling period and days from emergence to maturity of soybean variety S.J.4 as affected by different levels of nitrogen fertilizer were shown in Table III. There was no significant difference in the rate of seed filling during the effective filling period duration (log phase) among different nitrogen treatments. However, soybean receiving 60 kg N/rai had longer duration of effective seed filling period than those receiving 0, 20, or 40 kg N/rai. In comparison to the control, the application of 40 or 20 kg N/rai did not influenced the length of effective seed filling period.

An application of nitrogen fertilizer caused a remarkable delay in days to maturity of soybean variety S.J.4, and the delay was more pronounced at a higher rate of application. Lengthening of maturity especially at high rate of nitrogen application was attributed at least in part, from nitrogen effect on duration of seed filling.

Table II Number of pods per plant, number of seeds per pod and 100 seed weight of soybean variety S.J.4 receiving different amounts of nitrogen fertilizer in the form of $(NH_4)_2SO_4$.

Fertilizer level (N. kg/rai)	No. pod/plant	No. Seed/pod	100 seed wt. (g/100 seeds)
0	69.1	1.4	12.0
20	78.0	1.5	11.1
40	82.2	1.5	10.7
60	104.1	1.4	11.8
X̄	83.3	1.5	11.4
$LSD_{0.05}$	22.3	—	—
C.V. (%)	16.8	12.3	7.8

III. Nitrogen distribution in various soybean plant components

In this experiment, the percentage of nitrogen in vegetative components (stem, root and leaf), pod wall, and seed of soybean at weekly interval from seedling to maturity were also measured. The results reveals that there were no significant difference among treatments in term of percentage of nitrogen in various plant com-

Table III **Rate and duration of dry matter accumulation in soybean seeds, and days to maturity of soybean variety S.J.4 as affected by different amount of nitrogen fertilizer in the form of $(NH_4)_2SO_4$.**

Fertilizer level (N. kg/rai)	Rate of seed filling (g/days)	Duration of effective seed filling (days)	Days to maturity (days)
0	0.33	36.2	87.5
20	0.34	34.1	91.0
40	0.33	35.1	91.2
60	0.33	38.6	92.5
$\bar{x}$	0.33	36.2	90.5
$LSD_{0.05}$	—	2.54	1.4
$LSD_{0.01}$	—	—	2.0
C.V. (%)	6.74	4.4	0.97

ponents. Although the percentage of nitrogen in the vegetative part, pod wall and seed of soybean receiving 60 kg N/rai tended to be slightly higher than those of other treatments. atments. This result demonstrated the pattern of nitrogen distribution in soybean plant. At approximately 42 days after emergence (DAE) or 50 % flowering stage, nitrogen which normally accumulated in the vegetative portion decreased slightly and transferred to pods and seeds. As the seed growth rate rapidly increased, nitrogen from pod wall was transferred to seed of soybean and resulted into the decrease in percentage of nitrogen in pod wall. It is obvious that during the period of seed growth and accumulation of dryweigth, soybean seed become an active sink not only for carbohydrate but also for nitrogen as well.

Soybean seed did not only require carbohydrate during the seed filling period, but also nitrogenous compound as well. This study supported the finding of Thibodeau and Jaworski (1975) who claimed that during the effective filling of seed, both nitrogen fixation and nitrate reduction processes were no longer active and the plant has to satisfy nitrogen requirement of

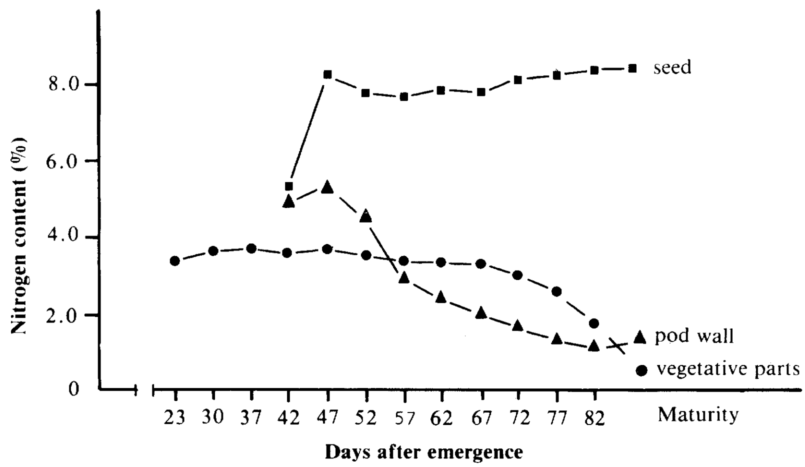

Figure I Nitrogen content (%) in various plant components of soybean variety S.J.4 during the entire growth period.

Figure I demonstrated the distribution of nitrogen in vegetative parts, pod wall and seeds of soybean variety S.J.4. Value of nitrogen used in this figure were means of nitrogen tre- seed by translocating nitrogen from leaves and stems. Losing nitrogen from the vegetative parts earlier than usual would cause early senescence of leaves and therefore the seed size and yield would also be decreased.

The way in which the transfer of nitrogenous compound from vegetative parts to seed be minimize is either to apply nitrogen fertilizer to soybean or increase the activity of nitrogen fixation. There is a possibility of complimenting this two processes by conducting research in the area of using starter N in nodulating soybean. In spike of the fact that using only nitrogen fixation process minimize the cost in soybean production, however if yield increases will be limited by inadequate nitrogen status of plant, by researching in the area of nitrogen application might offer an alternative path in increasing the yield of soybean.

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