PENGARUH NAUNGAN PADA BERBAGAI TAHAP PERKEMBANGAN
DAN POPULASI TANAMAN TERHADAP PERTUMBUHAN, HASIL,
DAN KOMPONEN HASIL KEDELAI [Glycine max (L.) Merr.]

oleh
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RINGKASAN


Rancangan petak terbagi digunakan pada percobaan pertama dengan tiga ulangan. Intensitas naungan dan saat dimulainya penaungan merupakan petak utama \( (L_{60T}^T): \) 60 persen naungan yang dimulai sejak tanam, \( L_{60B}^B: \) 60 persen naungan yang dimulai sejak awal pembuangan, \( L_{60P}^P: \) 60 persen naungan sejak awal pengisian polong, \( L_{80T}^T: \) 80 persen naungan yang dimulai sejak tanam, \( L_{80B}^B: \) 80 persen naungan yang dimulai sejak awal pembuangan, \( L_{80P}^P: \) 80 persen naungan sejak awal pengisian polong, dan \( L_0: \) tanpa naungan), sedangkan varietas merupakan anak petak \( (v_1: \) varietas Orba dan \( v_2: \) galur No. 1667). Percobaan kedua menggunakan rancangan petak terbagi dengan intensitas naungan dan dimulainya penaungan sebagai petak utama \( (L_{60B}^B: \) 60 persen naungan dimulai sejak awal pembuangan, \( L_{60P}^P: \) 60 persen
naungan sejak awal pengisian polong, $L_{80}^S_D$: 80 persen sejak awal pembungaan, $L_{80}^S_P$: 80 persen sejak awal pengisian polong, dan $L_0$: tanpa naungan), sedangkan populasi tanaman merupakan perlakuan anak petak ($P_1$: populasi 16 tanaman tiap meter persegi, $P_2$: 32 tanaman tiap meter persegi, dan $P_3$: 48 tanaman tiap meter persegi). Dilakukan dengan tiga ulangan. Varietas yang digunakan adalah No. 1667.

Laju asimilasi neto (LAN) tanaman yang dinaungi 60 dan 80 persen sejak tanam atau sejak awal pembungaan lebih rendah daripada laju asimilasi neto tanaman tanpa naungan. Hal ini terlihat selama pertumbuhan. Laju tumbuh pertanaman (LTP) juga dipengaruhi oleh naungan. Makin intensif naungan makin tertekan laju tumbuh pertanaman. Pada umumnya laju tumbuh pertanaman pada tanaman tanpa naungan lebih tinggi daripada tanaman yang dinaungi; laju tumbuh pertanaman terkecil terdapat pada tanaman yang dinaungi 80 persen sejak tanam.

Indeks luas daun (ILD) tanaman tanpa naungan mencapai maksimum pada umur sekitar 48 hari setelah tanam. Tanaman yang dinaungi baru mencapai nilai tertinggi dari indeks luas daun pada umur sekitar 56 hari setelah tanam. Naungan 80 persen sejak tanam menyebabkan rendahnya indeks luas daun, karena sedikitnya daun yang terbentuk pada tanaman tersebut.

Penaungan terutama intensitas naungan 80 persen, menurunkan hasil biji. Penaungan yang dimulai pada awal pengisian polong kurang merugikan dibandingkan dengan penaungan yang dimulai sejak awal pembungaan atau sejak tanam. Penurunan hasil biji pada perlakuan pen-aunang sejak tanam atau awal pembungaan terutama disebabkan oleh kurangnya polong yang terbentuk. Sedikitnya polong pada tanaman yang dinaungi 80 persen sejak tanam, besar kemungkinan disebabkan
oleh rendahnya daya tanaman dalam berfotosintesis seperti ditunjukkan oleh rendahnya laju asimilasi neto. Sedangkan sedikitnya polong pada tanaman yang dinaungi 80 persen pada awal pembuahan diduga karena meningkatnya penggguruan bunga yang baru terbentuk. Penurunan hasil pada penanaman selama masa pengisian polong mungkin disebabkan oleh terganggunya keseimbangan hubungan pembentuk dan penyimpan akit bat penurunan intensitas cahaya. Penaungan sejak awal pengisian polong mengakibatkan peningkatan banyaknya polong hampa dan penurunan indeks biji.

Sifat-sifat agronomi serta komponen hasil kedelai yang diukur antara tanaman yang dinaungi dengan tanaman yang tidak dinaungi menunjukkan perbedaan yang nyata; tanaman yang dinaungi tumbuh lebih tinggi, dengan cabang sedikit, buku kurang, garis tengah batang lebih kecil, kurangnya polong tiap tanaman, indeks biji rendah, lebih banyak polong hampa dan kadar nitrogen yang lebih rendah.

Peningkatan populasi tanaman dari 16 menjadi 32 tanaman tiap meter persegi menaikkan hasil biji, akan tetapi peningkatan populasi tanaman menjadi 48 tanaman tiap meter persegi menurunkan kembali hasil biji.

Hasil-hasil utama penelitian tersebut di atas mengandung implikasi-implikasi penting terhadap pola penanaman ganda dengan kedelai sebagai salah satu komponennya. Penurunan hasil biji kedelai akan menjadi minimal apabila naungan tidak terjadi sebelum awal pengisian polong, ditinjau dari segi persaingan cahaya.
SUMMARY

EFFECTS of SHADE at DIFFERENT STAGES of PLANT DEVELOPMENT
and PLANT POPULATION on GROWTH, YIELD, and YIELD COMPONENTS
of SOYBEAN [Glycine max (L.) Merr.]

INTRODUCTION

Various research workers have studied the effect of shading on
crops, but not many studied the shading effects on soybean. Kuo,
Tsay, and Tsuo (1977) have conducted the experiment of shading on
different stages of soybean growth. They found that shading at the
pre-flowering or flowering stages would give a slightly lower yield,
while shading during pod formation stage did not decrease the yield
significantly, but shading during the pod filling stage would give
the highest decrease in yield.

It has been known that increasing soybean yield can be done by
managing it to intercept the solar radiation as much as and as long
as possible during reproduction period. Since most of the farmers in
Asia grow soybean in multiple-cropping with other crops, such as corn
or cassava which are usually taller, it is of practical importance to
know the effects of shading intensities and duration of shading to
soybean yield and the relation of plan density and yield. It is the
objective of the experiments to know the effects of shading at diffe-
rent stages of soybean development and the best plant density.
MATERIALS AND METHODS

Two experiments were conducted. The first experiment was conducted from July through October 1977 and the second experiment was conducted from July through October 1978. Both experiments were conducted at the Bogor Agricultural University Experiment Station, Darmaga, Bogor, on a red brownish latosol. The land was formerly wet sawah with a texture containing 31.82 to 64.44% clay, 18.46 to 42.6% ash and 13.04 to 35.12% sand material (Appendix Table 1).

The field was pulverized to a good tilth and leveled immediately before planting so that the seed could be planted in smooth, moist soil. Soybeans Orba and No. 1667 with 98 percent germination rate was planted by hand, and thinned two weeks later to desired population densities.

Shades, made of Meranti wood slabs of 4 m length, 5 cm width and 1 cm thick, were placed on wooden frames, and placed in soybean plots in such a way as to cover all the plants underneath. To get the 60 and 80% of shading intensities, the wood slabs were arranged 3 and 1 cm apart, respectively (Figure 1).

Solar radiation was measured by using Gunn Bellani radiation integrator in the first experiment and bimetal actinograph in the second experiment. Relative humidity data were collected from Assman psychrometer. Three maximum-minimum thermometers were placed in each shade and a check plot at about 75 cm height. Soil temperatures were checked by using bimetal thermometers.
First experiment

The objective of the first experiment was to study the effect of shade intensity and the timing of shading to soybean growth, yield and components. It is hypothesized that yield decrease due to shading would be minimized when shading start at the right growth stage and at a tolerable intensity.

In order to test the hypothesis soybean were planted in a split plot design with three replications. Shade intensity and stage of soybean growth when shading was started was used as main plot. Variety, i.e. ORBA and No. 1667 was used as sub plot.

The following shading treatments were given: No shading (100 percent sunlight), also regarded as check; 60 percent shading, applied since planting; 60 percent shading applied since beginning of flowering; 60 percent shading applied since beginning of pod filling; 80 percent shading applied since planting; 80 percent shading applied since beginning of flowering; 80 percent shading applied since beginning of pod filling.

Sample plants were taken at the following stages: early vegetative stage, when three trifoliate leaves were unrolled; early flowering, when 1 to 5% of plants bear flowers; peak of flowering, stage, when 75% of plants bear flowers; pod formation, when pods are formed at lower parts of plants; pod filling, when pods of all sizes are present and 1 to 5% of plants bear filled pods; pod maturity; harvest.

The following plant characters were measured: stem length and diameter; number of branches, number of nodes; leaf area; dry weights: roots, nodules, stem and petioles, leaves, and pods; nitrogen content in stem and petioles, leaves, and pods.
Yield and yield components measurements included: yield, computed from plots of 1.0 m x 2.5 m, expressed in gram/m² grains at 14% moisture content; number of pods per plant; number of seeds per pod; seed index; and nitrogen content of seeds.

Second experiment

The objective of the second experiment was to study the effect of different plant densities to yields of soybean obtained under different shade intensities and timing.

Soybean were planted on July 5, and 6, 1978 in a split-plot design with three replications. Plots consisted of 12 rows, 1.50 m long, with row spacing of 25 cm, and within row spacing depends on plant population desired.

Shading or level of light and stage of soybean growth at which the shading treatment was started was used as mainplot. There were three levels of shading, i.e. 0, 60, and 80 percent. The shading levels of 60 and 80 percent were given during the period of early flowering stage, or early pod filling stage until harvest. The zero percent shading, or actually without shading, was considered as a check. The subplot treatments were the population densities, namely 16, 32, and 48 plants per square meter.

The yield and yield components were determined immediately after the mature plants were harvested. The yield components were determined from ten sample plants taken at random from each plot. The following characteristics were considered as yield components, i.e. number of pods per plant, number of seeds per pod, seed index (g/100 seed), number of branches per plant, number of nodes per plant,
and plant height. Grain yield was counted from 3.25 square meters of each plot and is expressed in g/m$^2$ of grain at 14 percent moisture content.

RESULTS

First experiment

1. Photosynthesis productivity

   a. The Net Assimilation Rate (NAR) of shaded plants measured at the vegetative stage was significantly lower than those of unshaded plants. Shading at the beginning of flowering lowered NAR; however, shading at the beginning of pod filling caused the rate of NAR to decrease slower than unshaded plants (Figure 15 and 16, and Table 18).

   b. The higher the shading intensity the lower the Crop Growth Rate (CGR). In general, CGR of unshaded plants was higher compared to those of shaded plants; the lowest CGR was obtained from plants shaded at 80 percent since planting. Crop growth rate of unshaded plants at the last measurement (56 to 76 days after planting) was lower than those of plants shaded since the beginning of pod filling. This low CGR of unshaded plants was mainly caused by lower dry weight of roots, stem, and leaves. Shading at the late stage extends the vegetative period (Figure 17 and 18, and Table 20).

   c. The Leaf Area Index (LAI) of unshaded plants reached the maximum at 48 days after planting that is as high as 4.53 (Orba) and 4.59 (No. 1667). Shaded plants reached their LAI maximum at a later date, i.e. 56 days after planting except the plants shaded 60 and 80 percent since planting which reached the maximum LAI at 48 days after
planting (Figure 19 and Table 20). Eighty percent shading since planting depressed significantly the growth of leaf area index, by having fewer leaves compared to other shading treatments; even though the individual leaf size of unshaded plant is thinner but broader than unshaded one.

2. Yield components and grain yield
   
a. The number of pods per plant was significantly affected by shading. At 80 percent shade intensity since planting resulted the least number of pods per plant, namely 8.2 for ORBA and 8.1 for No. 1667. At 60 percent shade intensity, even when given since the time of planting resulted in higher number of pods per plant, namely 19.7 for ORBA and 21.3 for No. 1667 compared to plants shaded by 80% since early flowering (Table 25). Shading at 60 percent intensity beginning at pod filling resulted 40.1 and 38.1 pods per plant respectively for ORBA and No. 1667. This is about 97 and 92 percent of the number of pods per plant obtained from unshaded plants.

   b. The number of seeds per pod was significantly depressed by shading. The earlier and the more intensive shading the lower the number of seeds per pod. There is a significant difference of seeds per pods obtained from the two varieties, with ORBA leading No. 1667 except under 80 percent shading given since planting (Table 25).

   c. Seed index was significantly affected by shading. The earlier and more intensive the shading the larger the seed index. At 80 percent shading given since planting resulted in the largest seed index for ORBA, namely 12.6 g/100 seed. The largest seed index obtained for No. 1667 was at 60 percent shading since planting.