

# YIELD AND SEED QUALITY OF SOYBEAN (*Glycine max* (L.) Merr.) AS AFFECTED BY THE APPLICATION OF DEFOLIANTS

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## Abstrak

Suatu penelitian dengan percobaan telah dilakukan untuk mengetahui pengaruh penyemprotan beberapa jenis defoliant dan saat penggunaannya terhadap hasil dan kualitas benih kedelai. Penelitian ini juga bermaksud untuk mengetahui pengaruhnya terhadap umur panen. Defoliant yang dipergunakan adalah: Sodium chlorate, 2,4 D ester, Glyphosate dan pemetikan daun secara manual sebagai control. Saat penyemprotan pada tingkat kemasakan benih yang berbeda: saat 10% benih masak, saat 50% benih masak, saat 90% benih masak dan saat seluruh benih telah masak dan polong berwarna coklat.

Penyemprotan defoliant sebelum benih masak fisiologis, secara nyata menurunkan berat 100 butir biji, prosentase perkecambah, vigor index, hasil dan meningkatkan prosentase kecambah abnormal. Penyemprotan defoliant memperpendek umur panen kedelai.

Penyemprotan dengan Sodium chlorate tidak berpengaruh terhadap kualitas fisiologis benih. Kecambah abnormal ditandai dengan adanya hipocotil yang pendek, daun pertama tidak berkembang, juga pada tunas yang tumbuh tidak normal.

## Abstract

An experiment to evaluate the effects of various defoliants and time of application on soybean has been done. The various defoliants used were: Sodium chlorate, 2,4 D Ester, Glyphosate and handpicking defoliation as control. The defoliants were applied at different stages of seed maturity: 10% of seeds have reached their physiological maturity, 50% have reached their maturity, 90% have reached their maturity and at post physiological maturity (when almost of pods have turned to brown).

Application of defoliants prior to physiological maturity of seeds, significantly reduced one-hundred seed weight, germination percentage, vigor index, yield and increased the percentage of abnormal seedlings. The abnormal seedling are exhibited by the stunted hypocotyl, defective primary leaves and terminal buds.

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The application of defoliant shortened harvest-age at the range of eight to twenty one days.

## Introduction

The quality of soybean seed is greatly influenced by prevailing environmental conditions. From the time the seed reached its physiological maturity until the time of harvesting, field deterioration is a serious factor. As a result of field deterioration, soybean seeds lose their viability and vigor, even before they are harvested (Agrawal, 1980). Mineral deficiency during plant growth, water stress, high and low temperature, diseases and damages caused by pests may also cause the deterioration.

A seed is at its highest level of quality at physiological maturity. It starts deteriorating immediately after reaching physiological maturity. In seed production it is of great importance to harvest seeds at the point of physiological maturity, for at that stage the greatest yield and the best seed quality level are obtained.

In fact, at the time soybean seeds achieve their physiological maturity, the leaves are still green, and some are beginning to turn to yellow, making it difficult to harvest. The crop is usually harvested when nearly all of the leaves had dropped. And this period usually takes about three weeks to reach, from at the point of physiological maturity, where seeds are exposed to environmental conditions which will cause seed deterioration.

Foliar chemical spray may be used to hasten defoliation and enhanced drying of seeds evenly, so that the harvesting can be done earlier. The application of defoliant is more effective in dry season when it is not cloudy, the relative humidity is low, and temperature is high (Harmond et al., 1961).

This study was conducted to determine the effect of defoliant on yield and seed quality of soybean and the effectiveness of defoliant in accelerating harvest-time.

## Materials And Method

The seeds of soybean cultivar UPLB Sy-2, were obtained from Institute of Plant Breeding (IPB), University of the Philippines, at Los Banos. Two soybean plants were grown in each pot (size 12) per treatment replicated four times.

The design of the experiment was a two factor factorial laid out in RCBD. The factors were the following: three kinds of herbicides and control as defolians and time of application (four stages). Defolians: D0 = control, D1 = sodium chlorate (10 grams/l), D2 = 2,4 D Ester (4 cc/l), D3 = glyphosate (15 cc/l).

Time of application (T): T1 = when 10% of pods have turn to yellow. T2 = when 50% of pods have turned to yellow. T3 = when 190% of pods have turned to yellow. T4 = when 90% of pods have turned to yellow and 10% have turned to brown.

Top soil of Lipa Series was used and it was air dried then pulverized and screened. The soil was mixed uniformly and a sample was taken and sent to the Bureau of soils for analysis. Approximately eight kilograms of soil were placed in each pot. Based on the results of soil analysis, complete (14-14-14) fertilizer was applied at the time of planting, at the rate of 2.0 grams per plant.

The seeds were treated before planting. Dithane M-45 was used for seed dressing at the rate of two grams a.i/kilogram of seed. *Rhizobium japonicum* strain CB 1809 inoculant was applied at the rate of 200 grams/50 kgs of seeds. Watering was immediately done after planting to provide sufficient moisture for germination. Succeeding watering were done regularly every two days. The crop was harvested when most of leaves had already dried out and dropped.

## Results And Discussion

**Seed yield.** There were no significant differences due to the application of various defolians, but significant differences in the effect of time of application of defolians were noted (Table 1).

Table 1. Means soybean seed yields (gram/pot) as affected by various defolians and time of application.

Defolians/Time of Application	T1	T2	T3	T4	Mean
D0	33.65c-e	37.84a-e	38.53a-e	44.25	38.57 a
D1	32.95de	38.41a-e	42.81ab	39.89a-d	38.51 a
D2	33.70c-e	38.91a-e	39.74a-d	39.98a	38.08 a
D3	31.36 e	36.40b-e	42.47ab	41.39a-c	37.90 a
Mean	32.90c	37.80b	40.89ab	41.38a	

Means in rows and columns having letters in common are not significantly different at 5% probability level, using DMRT.

The lowest yields were obtained when defoliant were applied at T1. Application at T2 gave higher yields which are significantly different from T1. Application of defoliant at T3 and at T4 gave the highest yields which are significantly different from T1 and T2. The low yields caused by the application of defoliant at T1 and at T2 could be attributed to the curtailment of the assimilate production and translocation to the developing seeds resulting to the low seed weight.

**A hundred seed weight.** Application of defoliant at different stages of seed maturity had a significant effect on the one hundred seed weight, but there are no significant differences among various defoliant (Table 2).

Table 2. Means one-hundred seed weight (gram) as soybean seed as affected by various defoliant and their time of application.

Defoliant/Time of Application	T1	T2	T3	T4	Mean
D0	20.50a - d	19.20b - d	19.09cd	23.40a	20.55a
D1	18.25 d	20.51a - d	20.53a - d	20.62a - d	19.98a
D2	18.91cd	20.53a - d	21.86a - c	20.57ab	20.97a
D3	18.53cd	19.13b - d	20.56a - d	21.19a - d	20.00a
Mean	19.05c	20.00bc	20.51b	21.94a	

Means in rows and columns having letters in common are not significantly different at 5% probability level using DMRT.

Application of defoliant at T1 gave the lowest one-hundred seed weight, although it was not significantly different from T2. The application of defoliant at T4 gave the highest one-hundred seed weight which are significantly different from the other treatments.

**Germination percentage.** Statistical analysis showed that there were significant differences among treatments. The data on germination percentage of soybean as affected by application of various defoliant and their time of application are presented on Table 3.

Low germination percentages were obtained from the application of 2,4 D Ester (D2) and the application of glyphosate (D3) at T1 and T2. While the application of Sodium chlorate and hand-picking defoliation, regardless the time of application resulting in the higher germination percentage. Likewise, application of 2,4 D Ester and Glyphosate at T3 and at T4 resulted the high germination percentage ranging from 86.0 to 94.0 per cent.

**Table 3. Means germination percentage of soybean seeds as affected by the various defoliant and their time of application.**

Defoliant/Time of Application	T1	T2	T3	T4	Mean
D0	92.5a	91.5a	93.7a	91.0a	92.1a
D1	89.2a	93.5a	90.5a	90.0a	90.8a
D2	19.5d	54.0b	88.2a	88.7a	62.6b
D3	2.2e	41.5e	86.0a	90.7a	56.6c
Mean	52.3c	70.1b	89.6a	90.1a	

Means in rows and columns having letters in common are not significantly different at 5% probability level using DMRT.

**Vigor index.** There were significant differences on vigor index among treatments. The data for vigor index of soybean seedlings are presented on table 4.

**Table 4. Means vigor index of soybean seedlings as affected by various defoliant and their time of application.**

Defoliant/Time of Application	T1	T2	T3	T4	Mean
D0	30.1bc	33.7a	31.1a - c	31.1a - c	31.5a
D1	29.4c	32.1a - c	31.3a - c	31.0a - c	31.0a
D2	5.3d	19.2d	30.9a - c	29.4c	21.2b
D3	3.3d	17.0d	29.1c	32.9 ab	20.6b
Mean	17.0c	25.5b	30.6a	31.1a	

Means in rows and columns having letters in common are not significantly different at 5% probability using DMRT.

Application of 2,4 D ester (D2) and Glyphosate (D3) at T1 and at T2 gave low vigor index and were significantly different from T3 and T4. Vigor index of soybean seedlings were not affected by the application of Sodium chlorate and defoliation by handpicking at stages of seed maturation.

**Percentage of abnormal seedlings.** Statistical analysis showed that there were significant differences in the incident of abnormal seedlings among the treatments. The data of the percentage of abnormal seedlings are presented on table 5.

Table 5. Means percentage of abnormal seedlings of soybean as affected by various defoliant and their time of application.

Defoliant/Time of Application	T1	T2	T3	T4	Mean
D0	7.2c	8.2e	6.2e	8.7e	7.6c
D1	10.7e	6.2e	9.0e	10.0e	9.0c
D2	78.0b	45.2d	11.7e	11.2e	36.5b
D3	89.7a	58.2c	13.7e	9.2e	42.7e
Mean	46.4a	29.5b	10.1c	9.8c	

Means in rows and columns having letters in common are not significantly different at 5% probability level using DMRT.

Handpicking defoliation (D0) and the application of Sodium chlorate (D1) gave low incidence of abnormal seedlings and they were not significantly different. The application of 2,4 Ester and Glyphosate at T1 and at T2 gave the higher percentage of abnormal seedlings compared to the application of them at T3 and at T4.

**Harvest-age.** Statistical analysis showed that there were significant differences in harvest-age of plants among treatments. The data of harvest-age area presented on table 6.

Table 6. Means harvest-age of soybean (days) as affected by various defoliant and their time of application.

Defoliant/Time of Application	T1	T2	T3	T4	Mean
D0	84.2h	87.5e	90.2cd	91.5b	88.3b
D1	85.5g	86.2f	89.7d	90.5c	86.7c
D2	86.5f	88.5d	91.2b	94.0a	90.0a
D3	86.5f	88.5d	91.2b	93.7a	90.0a
Mean	84.4d	87.6c	90.6b	92.4a	

Means in rows and columns having letters in common are not significantly different at 5% probability level using DMRT.

Application of defoliant at different stages of maturity gave harvest-age which were significantly different. The shortest harvest-age was obtained from the application of sodium chlorite (D1) and this was significantly different compared to the other treatments. The application of the other defoliant gave longer harvest-age, but were

still shorter compared to untreated plants, which needed 101 days to harvest.

The application of defoliant physically damaged the ultrastructural of leaf cells i.e sodium chlorate resulted cell membranes disintegration, leaf burning, and then petioles abscission. While 2,4 D ester caused tissue swelling, leaf decay, petiole collapse and then abscission. Glyphosate caused disruption of chloroplast envelope, disintegration of endoplasmic reticulum, wilting and then petiole abscission. The application of the herbicides when almost seeds have not reached physiological maturity (T1), resulted to leaf abscission after six to 14 days. Application at the further stages needed shorter period to get all leaves dropped.

The earlier dropped of the leaves resulted the pods dried out faster. Therefore the crop could be harvested earlier, compared to the untreated plants, on the other hand, the harvest-age could be shortened.

The visual symptoms of the application of defoliant were; wilting, curling, the collapse of the petioles and abscission. The undesirable thing was the stem collapse caused by the application of 2,4 D ester, making the plants can not be harvested mechanically.

The application of systemic herbicides (2,4 D ester and glyphosate) at T1 and T2 resulted in the higher abnormal seedlings. It was indicated that probably some of intact herbicide was translocated to the developing seeds and then disturbed the seeds metabolic activities during seed germination, resulting in abnormal seedlings.

From the above result and discussion, shown that defoliant affected the plants in three ways: first, resulted the damage of ultrastructural of leaf cells, stem collapsed, and leaves dropped; second, caused disfunctional metabolic activities particularly in leaf, stem and seeds; and third, indirectly affected seed quality which was appeared on abnormal seedlings (as affected by the using of systemic defoliant at the time when most of seeds have not reached physiological maturity).

## Conclusion

Defoliation at the early stage of maturity when most of pods were still green significantly reduced the seed yield. Application of Sodium chlorate was most effective to shorten harvest-time, while application of 2,4 D Ester and Glyphosate were less effective, although they were still better than the untreated plants.

On the basis of the overall results, it appears that all kind of defoliant used in this study can shorten the harvest-age at the range

from eight to 21 days (untreated plants needed 101 days to harvest). The application of defoliant are better at the time when the seeds had already reached their physiological maturity to get the highest yield and seed quality. In case of Sodium chlorate (non systemic herbicide) acts as desiccant, the results showed that it can be used at all stages of maturity without any significant reduction on physiological quality of seeds.

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