EFFECT OF TIME OF HARVEST AND SEED SIZE ON SEED QUALITY OF SOYBEAN

By

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Faculty : Agriculture

Soybean is one of the most important legume crop in Indonesia. It is widely cultivated in several agro-ecosystems to meet the local needs. The availability of high quality seeds is essential for increased productivity but is often neglected. Farmers use seeds from the previous planting irrespective of season, harvest time and bulk seeds of varying size together. This study was undertaken in three step wise experiments in order to study the effect of the current practices on seed quality, namely (1) to understand the effect of production environment (wet and dry seasons) and time of harvest on seed quality, (2) to study the effect of seed size within cultivar on seed quality, and (3) to determine the agronomic performance of seed lots within cultivar differing in seed size. Seed quality was assessed using the value of its potential longevity (K_i, in probit scale), the intercept of the transformed seed survival curve into probit scale. Production environment affected seed quality, whereby seeds produced in wet season had lower quality than those in dry season, as indicated by lower seed potential

longevity (K_i). The response of six soybean cultivars to production environment on seed size and crop duration was similar. Physiological maturity or mass maturity occurred at around developmental stage R6 + 15 days while maximum seed quality occurred five days later. Since farmers generally harvest soybean at around developmental stage R6 + 15 days, delaying harvest until some time after mass maturity will ensure better seed quality. Seed quality as indicated by K_i value positively correlated with oligosaccharides, especially raffinose but negatively correlated with monosaccharides as noted between seasons, among cultivars and harvest times. On the other hand, the relative amount of pectin methyl esterase (PME) negatively correlated with seed potential longevity. This suggests that oligosaccharides and PME play a role in determining quality of seed.

Small sized seeds within cultivar comprised 13.8 – 16.5% of total seed produced and they exhibited lower quality than large seeds. This is largely attributed to late pollination and thus resulting in shorter grain filling period. Large and medium sized seeds within a cultivar did not differ much in quality but large seeded cultivars had much lower K_i value, indicating poorer storability. If such seeds are to be stored, more attention in relation to storage condition should be given as compared to small seeded cultivars. Differences in seed quality as shown by the K_i value correlated positively with oligosaccharides and negatively with pectin methyl esterase (PME). Interestingly, when the data of soluble sugars and PME from the first and the second experiments were pooled, and a simple linear model relating seed potential longevity with soluble sugars and PME was constructed, the content of raffinose in seeds had strong contribution to seed potential

longevity, whereas PME had smaller contribution. These two biochemical substances could explain 75% of the variation in seed potential longevity. Thus, the changes in both the content of raffinose and the relative amount of PME in seed may partly explain the changes in seed potential longevity due to the difference in production environment, time of harvest, and seed size. Cultivars responded differently in its agronomic performance when planted under optimal condition. Plants from large sized seeds had better growth parameters as compared to those from small sized seeds. Therefore, bulking should not be practiced, rather the 15% of small sized seeds should be removed from the seed lot.

Since soybean cultivation is a big industry in Indonesia, the establishment of a seed program should be initiated. Based on the results of the present study, this thesis provides a strong basic knowledge to help in establishment of a seed production plan, namely (1) seed production should be carried out in dry condition (dry season) *i.e.* during early dry season (EDS) or late dry season (LDS), (2) harvesting seeds should be done when the quality is at its maximal *i.e.* about five days after physiological maturity, (3) post harvest seed handling should be carried out properly especially for large seeded cultivars due to their faster deterioration rate and (4) grading should be done to exclude around 15% of small sized seeds. The above mentioned factors will ensure more uniform seed lot in terms of seed size, quality and stand establishment.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN MASA PENUAIAN DAN SAIZ BIJI BENIH TERHADAP KUALITI BIJI BENIH KACANG SOYA

Oleh

DIDIK HARNOWO

Oktober 2004

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Kacang soya merupakan tanaman kekacang terpenting di Indonesia. Ianya ditanam secara meluas di persekitaran yang berbeza agro-ekosistemnya. Biji benih yang berkualiti tinggi adalah penting bagi meningkatkan produktiviti, tetapi ianya sering diabaikan. Petani di Indonesia sering menggunakan biji benih daripada tanaman musim sebelumnya tanpa mengambilkira faktor persekitaran, masa penuaian dan saiz biji benih. Bagi memperbaiki sistem pengeluaran biji benih yang sedia ada, satu kajian telah dijalankan dan dibahagikan kepada tiga, iaitu (1) kesan persekitaran dan masa penuaian terhadap kualiti biji benih, (2) kesan perbezaan saiz biji benih terhadap kualiti, dan (3) tumbesaran serta hasil daripada biji benih yang berbeza saiz. Kualiti biji benih diukur berasaskan nilai potensi penyimpanan (K_i), iaitu nilai pangkasan pada paksi y pada graf percambahan biji benih terhadap masa setelah transformasi kepada skala probit dilakukan. Keadaan persekitaran semasa tumbesaran dan perkembangan biji benih

mempengaruhi kualiti biji benih, dimana biji benih yang dihasilkan dalam musim hujan adalah lebih rendah berbanding dalam musim kering, berikutan nilai potensi penyimpanan (K_i) yang rendah. Keenam-enam kultivar memberikan respon yang sama terhadap saiz biji benih dan jangkamasa kematangan walaupun persekitaran penanaman adalah berbeza. Kematangan fisiologi berlakukan sekitar fasa tumbesaran R6 + 15 hari manakala kualiti biji benih mencapai nilai maksimum lima hari selepas kematangan fisiologi. Oleh kerana petani menuai kacang soya sekitar fasa perkembangan R6 + 15 hari, menunda penuaian biji benih sehingga selepas kematangan fisiologi akan menghasilkan biji benih dengan kualiti yang lebih tinggi. Terdapat korelasi positif diantara oligosakarida terutamanya raffinosa dengan kualiti biji benih manakala monosakarida memberikan korelasi negatif dengan potensi penyimpanan. Sebaliknya, jumlah relatif pectin methyl esterase (PME) dalam biji benih juga mempunyai korelasi negatif dengan potensi penyimpanan biji benih. Ini menunjukkan bahawa kedua dua jenis bahan di atas mempunyai peranan dalam menentukan kualiti biji benih.

Biji benih kecil didalam satu cultivar berjumlah sekitar 13.8 – 16.5% daripada berat keseluruhan dan menunjukkan kualiti yang lebih rendah berbanding dengan yang berbiji besar. Biji benih kecil adalah biji benih daripada pembuahan yang akhir, oleh itu jangkamasa pengisian biji adalah lebih pendek. Biji benih besar dan sederhana tidak menunjukkan perbezaan yang besar dari segi nilai K_i (kualiti) tetapi kultivar berbiji besar mempunyai nilai K_i yang lebih rendah, melambangkan keupayaan penyimpanan yang rendah. Sekiranya biji benih kultivar besar hendak disimpan maka lebih perhatian harus diberikan terhadap persekitaran

penyimpanan berbanding dengan biji benih dari kultivar berbiji kecil. Perbezaan nilai *K*i akibat saiz biji benih menunjukkan korelasi positif dengan oligosaccharida dan korelasi negatif dengan PME. Apabila semua data gula terlarut dan PME daripada kajian pertama dan kedua dikumpulkan dan suatu model yang menghubungkan potensi penyimpanan dengan gula terlarut dan PME dibuat, maka raffinosa didapati memberikan sumbangan yang besar terhadap potensi penyimpanan manakala sumbangan PME lebih kecil. Kedua-dua bahan ini dapat menerangkan lebih kurang 75% daripada variasi pada potensi penyimpanan. Maka perubahan pada nilai gula raffinosa dengan PME dapat menerangkan sebahagian daripada perubahan nilai potensi penyimpanan yang diperolehi akibat persekitaran, masa penuaian dan perbezaan saiz biji benih.

Tindak balas cultivar terhadap tumbesaran serta ciri agronomi bagi biji benih berbeza saiz adalah berbeza walaupun ditanam pada keadaan optima. Pokok kacang soya yang berasal daripada biji benih besar menunjukkan pertumbuhan yang lebih baik berbanding dengan yang berasal daripada biji benih kecil. Oleh itu, bagi mendapatkan keseragaman, biji benih perlu digredkan dan kurang lebih 15% daripada biji benih bersaiz kecil harus dikeluarkan daripada lot biji benih.

Oleh kerana penanaman kacang soya di Indonesia merupakan industri yang besar, program industri biji benih yang maju harus diwujudkan. Berasaskan keputusan yang diperoleh daripada kajian yang dilakukan, tesis ini dapat memberikan sumbangan bagi mendirikan industri biji benih kacang soya, iaitu : (1) pengeluaran biji benih kacang soya harus dilaksanakan dalam musim kering,

sama ada dalam musim kering awal atau musim kering akhir, (2) penuaian biji benih harus dilakukan pada masa kualiti yang maksimum iaitu sekitar lima hari selepas kemasakan fisiologi, (3) pengendalian pasca tuai biji benih perlu dilakukan secara tepat terutamanya untuk kultivar bersaiz biji besar kerana ianya mempunyai kadar deteriorasi yang lebih cepat berbanding dengan biji benih dari cultivar bersaiz kecil, (4) semasa pemprosesan, biji benih perlu digredkan untuk mengeluarkan biji benih bersaiz kecil yang berjumlah sekitar 15% daripada berat biji benih keseluruhan. Faktor-faktor di atas akan menjamin keseragaman saiz biji benih dalam lot, kualiti serta kemampuan percambahan.

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I certify that an Examination Committee met on October 27, 2004 to conduct the final examination of Didik Harnowo on his Doctor of Philosophy thesis entitled "Effect of Time of Harvest and Seed Size on Seed Quality of Soybean" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members for the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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DIDIK HARNOWO

Date : 6 Januari 2005

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^{o}C	:	Degree Celcius
AA	:	Accelerated Aging
Anova	:	Analysis of Variance
AOSA	:	Association of Official Seed Analysts
APS	:	Ammonium Peroxydisulphate
BIS	:	N. N'-Methylenbisacrylamide
BPB	:	Bromophenol Blue
BSA	:	Bovine Serum Albumin
cm	:	centimeter
D	:	Day
DAS	:	Day(s) After Sowing
DMRT	:	Duncan's Multiple Range Test
EC	:	Enzymes Catalog
et al.	:	et alia
g	:	gram
Ha	:	Hectare
ISTA	:	International Seed Testing Association
i.e.	:	id est L.
KDa	:	Kilodalton
Kg	:	Kilogram
L	:	Liter
mg	:	milligram
ma	:	milliampere
mL	:	milliliter
mm	:	millimeter
M	:	Molar
nm	:	nanometer
PAGE	:	Polyacrylamide Gel Electrophoresis
PME	:	Pectin Methyl Esterase
ppm	:	part per million

rpm	:	rotary per minute
SAS	:	Statistical Analysis System
SDS	:	Sodium Dodecyl Sulfate
t	:	tonnes
TEMED	:	N, N, N, N, - Tetramethylethylendiamine
Tris-HCl	:	Tris-(hydroxymethyl)-aminomethane Hydrochloric Acid
mg	:	microgram
Wb	:	Wet basis