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SUMMARY:

Data are presented on the phenological, plant and seed characteristics of 301 accessions of soybeans (Glycine max) grown during the wet season in the Ord Irrigation Area, northern Western Australia. The accessions, mainly elite lines bred and selected by Dr D.E. Byth of the University of Queensland for adaptation to tropical areas, were grown in 20 experiments, covering 37 sowings between 1974 and 1980.

1 Division of Tropical Crops and Pastures, CSIRO Cunningham Laboratory, 306 Carmody Road, Brisbane, Queensland 4067.

2 Previously of Western Australian Department of Agriculture, Kununurra. Present address: c/- Department of Primary Production, P.O. Box 4160, G.P.O. Darwin, Northern Territory.

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PHENOLOGY, PLANT AND SEED CHARACTERISTICS OF A COLLECTION OF SOYBEANS (GLYCINE MAX) GROWN DURING THE WET SEASON IN TROPICAL AUSTRALIA

D.F. Beech[1], A.L. Garside[2] and I.M. Wood[1]

1 Division of Tropical Crops and Pastures, CSIRO Cunningham Laboratory, 306 Carmody Road, Brisbane, Queensland 4067.

2 Previously of Western Australian Department of Agriculture, Kununurra. Present address: c/- Department of Primary Production, P.O. Box 4160, G.P.O. Darwin, Northern Territory.

INTRODUCTION

Soybeans were first grown at Kimberley Research Station (KRS) (Lat. 15° 39'S, Long. 128° 43'E) in the Ord Irrigation Area, northern Western Australia in 1957. During 1957 and 1958 a range of accessions from the USA, East Africa, the Sudan and Indonesia was grown during both the wet and the dry seasons. Difficulties were experienced with poor establishment, shattering at maturity, and damage by a longicorn beetle Zygrita diva in the wet season sowings and damage by the leaf eating caterpillar Spodoptera litura in the dry season sowings. The problems of insect damage were so serious that in 1960 further testing of soybeans at KRS was suspended.

In 1974 testing of soybean genotypes was resumed at KRS by CSIRO and in 1977 the Western Australian Department of Agriculture began work on the evaluation of soybean genotypes at its Irrigation Research Station (IRS) in the Ord Irrigation Area. Initially a collection of elite selections of soybean bred by Dr D.E. Byth of the University of Queensland specifically for adaptation to low latitudes was evaluated at the two centres over a range of sowing dates from December to May. Later, additional material was introduced from other tropical areas and after regeneration in quarantine was tested in the field at KRS and the IRS.

Soybeans are quantitative short day plants, and daylength generally has a dominant influence on the pattern of phasic development and on vegetative and reproductive development (Byth 1968, Lawn and Byth 1973, 1974). Consequently the expression of many of the attributes associated with growth and reproductive development are affected by both the geographical location and the date of sowing at that location. Attributes such as height at maturity, height to lowest pod, seed size, oil content and the length of the period from sowing to maturity are all affected by location and sowing date and all are important determinants of the suitability of a particular genotype for commercial production. Height at maturity, height to lowest pod, yield/ plant and, to a lesser extent, phenology are also influenced by plant population.

Only two soybean cultivars have been registered for commercial production in tropical Australia. These are Buchanan and Durack which have both been registered for wet-season production in tropical areas. Buchanan is an early cultivar which is recommended for sowing in late

December or January in the Ord Irrigation Area and the northern higher rainfall areas of the Northern Territory. It is a sparsely branching cultivar and needs to be sown at a close row spacing of 25-30 cm for maximum yields. Its short growing season of 110-120 days when sown in late December or early January in the Ord Irrigation Area permits double cropping with dry season crops such as sunflowers and winter cereals. Durack is a late maturing cultivar recommended for late December or early January sowing in the Ord Irrigation Area; sown at this time it takes about 150-160 days to reach maturity. It is strongly branching and can be sown at wide row spacings of 75-100 cm if sown early in the wet season.

This communication lists the data collected for all soybean accessions grown in all wet season sowings (i.e. December to March) at KRS and the IRS during the period 1974-80. The data come from a number of different sowings ranging from short single nursery rows to larger-scale replicated trials. Data recorded from the different trials varied considerably so the data set is far from complete; we have presented it without any attempt at statistical analysis because we feel it will be a useful guide for agronomists and plant breeders seeking genotypes with particular attributes and will avoid the need to further screen these genotypes in the lower latitudes of northern Australia. In particular, the results on the response to sowing date, which is primarily a response to daylength, should be almost directly applicable to the northern higher rainfall areas of the Northern Territory and to the Burdekin Irrigation Area.

EXPERIMENTAL DETAILS:

Location, soil and environment

Kimberley Research Station and the Irrigation Research Station are both located in the Ord Irrigation Area at Lat. 15°39'S, Long. 128°43'E.

At both sites the experiments were sown on Cununurra clay (Ug 5.34, Northcote 1971), the dominant soil in the Ord Irrigation Area. It is a uniform dark brown medium to heavy clay with pronounced swelling and shrinkage characteristics; it is plastic and sticky when wet and cracks deeply when dry (Gunn 1969). Soil reaction is neutral at the surface but becomes alkaline at depth.

The climate of the area is monsoonal with well defined wet and dry seasons. The wet season extends from about mid November to the end of March and about 90% of the 773 mm mean annual rainfall falls during this period. A summary of the meteorological data for KRS is given in Table 1.

Experiments

The data presented come from 37 sowings made over six wet seasons between 1974 and 1980. Details of the sowings are summarized in Table 2.

Generally the sowings fell into three categories corresponding to stages in the process of screening, selecting and testing genotypes for commercial production.

Table 1: Meteorological data for Kimberley Research Station Values calculated from data recorded at Kimberley Research Station, 1946-1981. Mean rainfall data supplemented with data recorded at Ivanhoe Station, approx. 5 miles south, for period 1907-1945. Data from Cook and Russell 1983.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Mean rainfall (mm)	188	188	124	31	8	4	4	1	3	22	69	129	773
Mean max. temp. (°C)	36.0	34.9	35.6	35.2	32.8	30.6	30.5	32.9	35.9	38.5	38.9	37.8	35.0
Mean min. temp. (°C)	24.4	24.3	23.4	20.7	18.0	15.3	14.1	15.5	19.0	22.9	24.5	24.8	20.5
Evaporation (mm)	242	190	208	222	217	204	223	254	297	335	306	288	3030
Median daylength (hr & min)*	12 57	12 37	12 12	11 45	11 24	11 12	11 16	11 35	12 00	12 26	12 50	13 03	
**	13 44	13 21	12 55	12 29	12 09	11 59	12 03	12 19	12 43	13 09	13 36	13 50	

* Civil daylengths i.e. from civil sunrise (-50 min altitude) to civil sunset (-50 min altitude)

** Daylengths from sunrise to sunset plus civil twilight (-6° altitude before sunrise and after sunset)

In the first two years (i.e. 1974 and 1975) green vegetable bug was the most serious pest but subsequently the levels of infestation declined substantially. This appeared to be associated with an increase in the population and activity of a native wasp Trissolcus basalis whose larvae are parasitic on the eggs of green vegetable bugs. In 1980 another parasite Trichopoda which is parasitic on adult green vegetable bugs was released in the Ord River Irrigation Area. The other bugs were controlled when necessary by application of Endosulfan at rates of 2.1 ℓ ha^{-1} (35% a.i.).

The lucerne crownborer (Zygrita diva), a native longicorn beetle, has proved a serious pest with soybean crops sown during December (Wood 1976). The larvae of this beetle bore into and eat out the stem and then girdle the stem prior to entering diapause in the plants for the dry season. The damaged plants often ripen prematurely and they are also prone to break off during harvesting. A beanfly (Melanagromyza spp) whose larvae also are stem borers first appeared in soybean crops at the Ord in 1979 and has since proved a problem in crops sown in the late wet season i.e. March and April.

The cluster caterpillar (Spodoptera litura) and the yellow-winged locust (Gastrimargus musicus) have caused serious defoliation on a number of occasions but Heliothis spp. which has been a serious pest in other soybean areas has been only a minor pest. The lucerne seed web moth (Etiella behrii) and a leafroller caterpillar (Stomopteryx spp.) have also caused some problems.

Diseases

Two bacterial diseases, bacterial pustule (Xanthomonas campestris p.v. phaseoli), and common bacterial blight (Pseudomonas syringae p.v. glycinea) and the fungal disease charcoal rot (Macrophomina phaseolina) occurred in the soybean sowings at the Ord. Fortunately reasonable levels of resistance are available to both bacterial pustule and bacterial blight. The incidence of damage by charcoal rot appears to be associated with the incidence of water or heat stress, damage by herbicides or other unfavourable conditions adversely affecting crop growth.

ACCESSIONS:

Details of the 301 accessions included in the experiments are given in Table 3. The accessions generally fell into two categories, advanced breeding lines and cultivars. The advanced breeding lines included material bred in Australia specifically for low latitude areas by Dr D.E. Byth of the University of Queensland and by Dr J.L. Rose of the Queensland Department of Primary Industries, Hermitage Research Station, Warwick. However, it also included some breeding lines imported into Australia from Brazil.

The named cultivars were being grown commercially in tropical countries and therefore offered some promise of adaptation to the environment of tropical Australia. Unfortunately many of these cultivars were developed for labour-intensive cropping systems and are not suitable

for larger-scale mechanized production. However, a number do possess characteristics that make them suitable as parental material in a breeding program.

In preparing Table 3 and the data set (Tables 4-33) we have used the Commonwealth Plant Introduction (CPI) number as the primary identifier where this was available. Full details of CPI accessions can be obtained from the registers regularly published by the Plant Introduction Section, CSIRO Division of Plant Industry, Canberra.

DATA SET:

Details of the attributes on which data were recorded are given in Appendix A along with some definitions and comments. The data for the collection are detailed in Tables 4-33 which are on the microfiche in the pocket on the rear cover (a hard copy can be made available on request).

The grain yields shown in Table 17 were generally calculated from hand-harvested quadrats totalling 2-3 m in length and covering the full width of the bed top. The grain yields shown in Table 18 were calculated from machine harvests of whole plots. In making the calculations for both attributes it was presumed that the crop utilized the full 1.5 m width of the bed from furrow centre to furrow centre. As the bed top is normally 100 to 110 cm wide the yields calculated in this way are conservative and cannot be taken to indicate the true potential of the genotypes when sown under a system involving flat planting in close rows. Depending on the extent of the border effect grain yields under a flat planting, close row system could be up to 50% higher than shown in Tables 17 and 18. However, the yields as calculated are appropriate for the system where the crop is sown in rows on a formed bed.

With the two 1979/80 experiments 80KU25 and 80KU26 (see Table 2) yields were calculated from quadrats cut from the centre four of the six rows on the bed top. For these experiments the grain yields (Table 17) have been calculated on the basis of a continuous flat planting with comparable row spacing to that on the bed top.

The data from all experiments were stored as a data bank under the computer routine INFOL (Control Data Cooperation and Vogelbach Computing Centre, Northwestern University, Illinois, USA) which permits retrieval of the data and outputting in a wide range of formats. Where replicated data were recorded the outputs shown in the tables are the means over replicates.

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APPENDIX A

Details of attributes measured for the soybean accessions at the Ord Irrigation Area in sowings made from 1974 to 1980. Weights are dried weights after oven-drying at 85°C to constant weight. The tables are on the microfiche in the pocket on the rear cover.

Number of days from sowing to 50% flowering	Table 4
" " " " " to end of flowering [a]	" 5
" " " " " to first mature pod	" 6
" " " " " to maturity [b]	" 7
Crop height at start of flowering (cm)	" 8
" " " end of flowering (cm)	" 9
Crop height at maturity (cm)	" 10
Height to lowest pod (cm)	" 11
Plant dry weight at maturity (g)	" 12
Total above-ground dry matter yields at end of flowering (kg ha^{-1})	" 13
Total above-ground dry matter yields at maturity (kg ha^{-1})	" 14
Leaf dry matter yield at end of flowering (kg ha^{-1})	" 15
Leaf area index (LAI) at end of flowering[a]	" 16
Seed yield (calculated from sample quadrat) (kg ha^{-1})	" 17
" " (calculated from machine harvest) (kg ha^{-1})	" 18
" " (calculated from short rows) (g $plant^{-1}$)	" 19
Harvest index (%) [c]	" 20
1000 seed weight (g)	" 21
Oil content of seed (%)	" 22
Protein content of seed (%)	" 23
Flower colour white (W) or purple (P)	" 24

Seed colour	yellow (Y), green (G), brown (BR), black (BL), white (W)	Table 25
Plant type		" 26
	1 = uniculm	
	2 = moderately branched	
	3 = profusely branched	
Rating for leaf retention at maturity		" 27
	1 = little or no leaf at maturity	
	2 = substantial leaf retained at maturity	
Rating for evenness of pod ripening		" 28
	1 = even ripening	
	2 = uneven ripening	
Rating for pod shattering		" 29
	1 = no shattering	
	2 = moderate shattering	
	3 = severe shattering	
% plants tunnelled by Zygrita diva [d]		" 30
Growth habit	Determinate (D) Indeterminate (I)	" 31
Rating for resistance to leaf diseases (bacterial pustule and bacterial blight)		" 32
	0 = no resistance (i.e. disease severe)	
	↓	
	5 = complete resistance (i.e. no sign of disease symptoms)	
Crop potential rating[e]		" 33
	0 = no potential	
	↓	
	10 = excellent potential	

Explanatory notes

a. End of flowering is defined as when the major flush of flowering is finished with only sporadic flowering persisting. It is associated with the following changes in plant appearance: leaves tend to become erect and more shiny: leaves become more crisp: leaf colour deepens: leaf expansion ceases.

b. Maturity is defined as when 95% of the pods have lost their chlorophyll.

c. Harvest index is defined as the ratio of grain dry weight to total above-ground dry weight at maturity expressed as a percentage.

d. Zygrita diva is a native longicorn beetle whose larvae tunnel into the stems of the soybean plants (see Wood, 1976) causing premature ripening and a tendency for the plants to break off at maturity.

e. Crop potential rating is a visual assessment of the suitability of the genotype for commercial crop production. The assessment is made close to maturity and takes into account such aspects as yield, crop height, position of pods on the plant relative to the cutting height of a harvester, evenness of pod ripening, extent of pod shattering, level of leaf retention, extent of lodging and susceptibility to disease.