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Effects of Timing of Drought Stress on Abscission and Dry Matter Partitioning of Short-duration Pigeonpea

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With 4 figures and 4 tables

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Abstract

Shoot dry mass partitioning and cumulative abscission of leaf, flowers and pods were determined for nine short-duration pigeonpea genotypes grown with adequate soil moisture throughout growth (control), or subjected to water stress during the late vegetative and flowering (stress 1), flowering and early pod development (stress 2), or pod fill (stress 3) growth stages. The total cumulative dry mass of abscised plant parts was lower for determinate genotypes, but it increased to a greater extent under water stress than that of indeterminate genotypes, with stress 2 having the greatest and stress 3 the least effects. The dry mass contribution of pods to total abscission was < 5%, and not significantly affected by water stress, while the contribution of leaves increased and that of flowers decreased. Stress 3 had no significant effects on abscission dry mass totals or components. Reduction in shoot dry mass under water stress was most pronounced for genotypes in the early pod development stage, and the dry mass contribution of leaves generally decreased and that of pods increased under stress 1 and stress 2. With similar abscission levels, the shoot dry mass of genotype ICPL 151, was similar to, or greater than, that of hybrid ICPH 9, under stress 1 and stress 2, and the contribution of pods to shoot dry mass was lower for hybrid ICPH 9 under both stress treatments. Genotypic differences in drought resistance were likely due to differences in the leaf area maintenance during, and in the recovery of dry mass and pod production following, water stress periods.

Key words: Abscission, *Cajanus*: pigeonpea, drought resistance, dry matter partitioning, sensitive stage.

Introduction

Intermittent drought can reduce growth and yield of short-duration pigeonpea [*Cajanus cajan* (L.) Millsp.] to varying extents depending on its timing and the particular genotype (ICRISAT, 1988, 1989). Establishment of the physiological bases for genotypic differences in drought response can increase the efficiency of breeding and selection for drought tolerance, especially where the degree of susceptibility to drought varies among growth stages, and the rate of phenological development varies among geno-

types. In short-duration pigeonpea, seed yield is particularly sensitive to drought during the late flowering and early pod development stages, and reductions in both the total shoot dry matter (TDM) and the harvest index (HI) can occur (LOPEZ et al., 1996). The maintenance of TDM and HI under water stress conditions are likely to be affected by changes in the production and partitioning of dry matter among component plant parts, and in the abscission of leaves and reproductive units.

For pigeonpea subjected to water stress, both the interception of solar radiation and the

efficiency of its conversion into dry matter can be reduced (HUGHES and KEATINGE, 1983). Although relatively less dry matter is partitioned into shoots compared to roots under water stress (LOPEZ, 1986), seed yield of short-duration pigeonpea genotypes is linearly related to the shoot dry mass at final harvest under a particular soil moisture regime (LOPEZ et al., 1996). Periods of water stress may influence the rate of production and/or abscission of component shoot parts which can affect the relative capacities of the assimilate source (leaves) and sink (reproductive units), leading to changes in the TDM and/or HI.

For several grain legumes, leaf area development is very susceptible to water stress (PANDEY et al., 1984; MUCHOW, 1985; HOOGENBOOM et al., 1987; HUSAIN et al., 1990), while moderate water stress levels during reproductive growth can increase the proportion of shoot dry matter in pods (WIEN et al., 1979; TURK and HALL, 1980; ONG, 1984). For medium-duration pigeonpea under rainfed conditions, the cumulative dry mass of abscised plant material can exceed 2.0 t ha^{-1} , with leaves accounting for most of this amount (SHELDRAKE and NARAYANAN, 1979). The present study investigated the effects of drought stress timing on the abscission of leaves, flowers and pods, and the partitioning of dry matter among component shoot parts of short-duration pigeonpea.

Materials and Methods

Crop establishment

The experiment was conducted in an Alfisol (Udic Rhodustalf) field at ICRISAT Center, India (17°N , 78°E ; 500 m elevation), with two shelters that closed automatically to prevent rain on an experimental area of $50 \text{ m} \times 25 \text{ m}$. The soil had a maximum plant available water holding capacity of 60–100 mm. It was surface tilled incorporating 100 kg ha^{-1} of diammonium phosphate, and ridges spaced at 0.6 m were established. Prior soil analyses and plant growth tests had established that nutrient deficiencies would be unlikely in this soil and that native *Rhizobium* were adequate to ensure optimum nodulation and nitrogen fixation of pigeonpea. Seeds were hand sown on 7 July 1988, with two plant-rows (0.3 m apart) established on both sides of ridges and a spacing of 0.1 m within rows. Agronomic operations were carried out as necessary for adequate protection against pests, diseases and weeds. During the early growth stages, the experimental plots depended entirely on rainfall, and no supplemental

irrigations were given. From 52 days after sowing (DAS), the automatic rain shelters were activated to exclude rainfall and differential irrigation treatments commenced.

Experimental design and treatments

The experiment was laid out as a split-plot design with four replications. The four drought stress timing treatments applied in the main plots were: (a) Control – Optimum moisture (maintained near field capacity) throughout the crop growth period; (b) Stress 1 – Water withheld from 52 DAS until about 50% leaf abscission in genotype ICPL 87 (88 DAS); (c) Stress 2 – Water withheld from 50% flowering of ICPL 87 (78 DAS) until about 50% leaf abscission (102 DAS); (d) Stress 3 – Water withheld from mid-podfill of ICPL 87 (110 DAS) until harvest (133 DAS). Main plots were $10.5 \times 3.6 \text{ m}$ and were separated from each other by a 1.2 m wide border strip planted to ICPL 87. Water was applied by drip irrigation at intervals of 2–4 days depending on surface soil dryness in control plots. A flow meter on the main irrigation line indicated the amount of water applied on each occasion. Drought stress treatments were applied by closing lateral irrigation lines to specified plots.

Nine short-duration pigeonpea genotypes (sub-plot treatments) with varying growth habit (I = indeterminate, D = determinate), and other (H = hybrid, E = extra-early) characteristics were used in the study: (1) ICPL 87 – D; (2) ICPL 151 – D; (3) ICPL 85010 – D; (4) ICPL 85045 – I; (5) ICPL 85043 – I; (6) ICPH 8 – I, H; (7) ICPH 9 – D, H; (8) ICPL 84023 – D, E; (9) ICPL 85037 – I, E. Each subplot consisted of 4 rows (3.5 m long) on two adjacent ridges.

Abscission

Two perforated plastic trays, each 360 mm long, 260 mm wide, and 45 mm deep, were kept under the canopy in each plot of the control and stressed treatments during the development of each stress. Abscised leaves, flowers and pods collected in these trays were removed each week and the dry mass determined for each plant part. Small pods (length < 20 mm) were included with the flowers. Trays were kept in control plots from the start of stress 1 until the time of harvest, but were removed from stressed plots at the time of termination of each stress treatment. The cumulative abscission of each plant part was determined assuming that there were no differences in the abscission for unstressed plots prior to the commencement of the stress treatments.

Table 1. The effects of soil moisture treatments on the abscission (leaf, flower and pod; g m^{-2}) of seven short-duration pigeonpea genotypes¹ at the end of stress 1 and stress 2

Genotype	Growth habit ³	Stress 1 (52–88 DAS)		Stress 2 (78–102 DAS)	
		Control	Stressed	Control	Stressed
ICPL 85043	I	33.6	37.6	99.0	125.5
ICPL 85037	I	33.2	30.1	95.5	113.6
ICPL 151	D	19.4	28.2	67.5	95.1
ICPH 9	D	21.4	26.4	76.1	103.2
ICPL 85045	I	32.0	35.3	27.5	137.5
ICPL 87	D	17.0	25.1	67.6	97.3
ICPH 8	I	34.0	27.2	115.9	133.9
SE		$\pm 4.15 (\pm 3.82)^2$		$\pm 7.21 (\pm 7.08)^2$	

¹Genotypes are arranged in order of increasing time to flowering

²SE values in parentheses are for comparing means at the same soil moisture level

³I = Indeterminate, D = Determinate

Dry matter partitioning

Three plants were randomly selected and removed (by cutting at the base) from control and stressed plots (between 0900 and 1000 h) at the termination of stress 1 and stress 2. Similarly, five plants were removed from all plots at the time of final harvest (133 DAS), which coincided with the end of stress 3. Plants were transported to the laboratory in polyethylene bags and kept in a cold room at 5 °C until separation into component plant parts (leaves, stems, flowers and pods), which was completed on

the same day for sampling at the end of stress 1 and stress 2, and over 2 days at final harvest. Dry mass was determined for leaves, stem, flowers and immature pods after oven-drying at 80 °C to constant mass, and for mature pods after sun-drying for two weeks followed by oven-drying at 80 °C for 2 days. At final harvest, an additional category was created for the new flush growth which included the newly produced leaves and stem (both light green) and flowers.

Table 2. The total abscission, and the percentage contribution of leaves, flowers and pods for seven short-duration pigeonpea genotypes¹ at the end of stress 3²

Genotype	Total (g m^{-2})	Components		
		Leaf (%)	Flowers (%)	Pods (%)
ICPL 85043	149.4	60	37	3.3
ICPL 85037	165.6	60	37	3.1
ICPL 151	170.0	67	29	4.6
ICPH 9	177.7	72	26	2.1
ICPL 85045	202.1	67	29	4.2
ICPL 87	176.8	74	22	4.2
ICPH 8	187.2	72	26	2.2
SE	± 8.09	± 1.3	± 1.7	± 0.9

¹Genotypes are arranged in order of increasing time to flowering; their growing habits are as indicated in Table 1

²Data for control and stress 3 were pooled for each genotype since treatment effects were non-significant

Data analysis

Data were analysed using standard analysis of variance procedure using GENSTAT software.

Two earliest flowering genotypes, ICPL 85010 and ICPL 84023, produced a second flush of pods by the time of final harvest and were therefore omitted from the analysis.

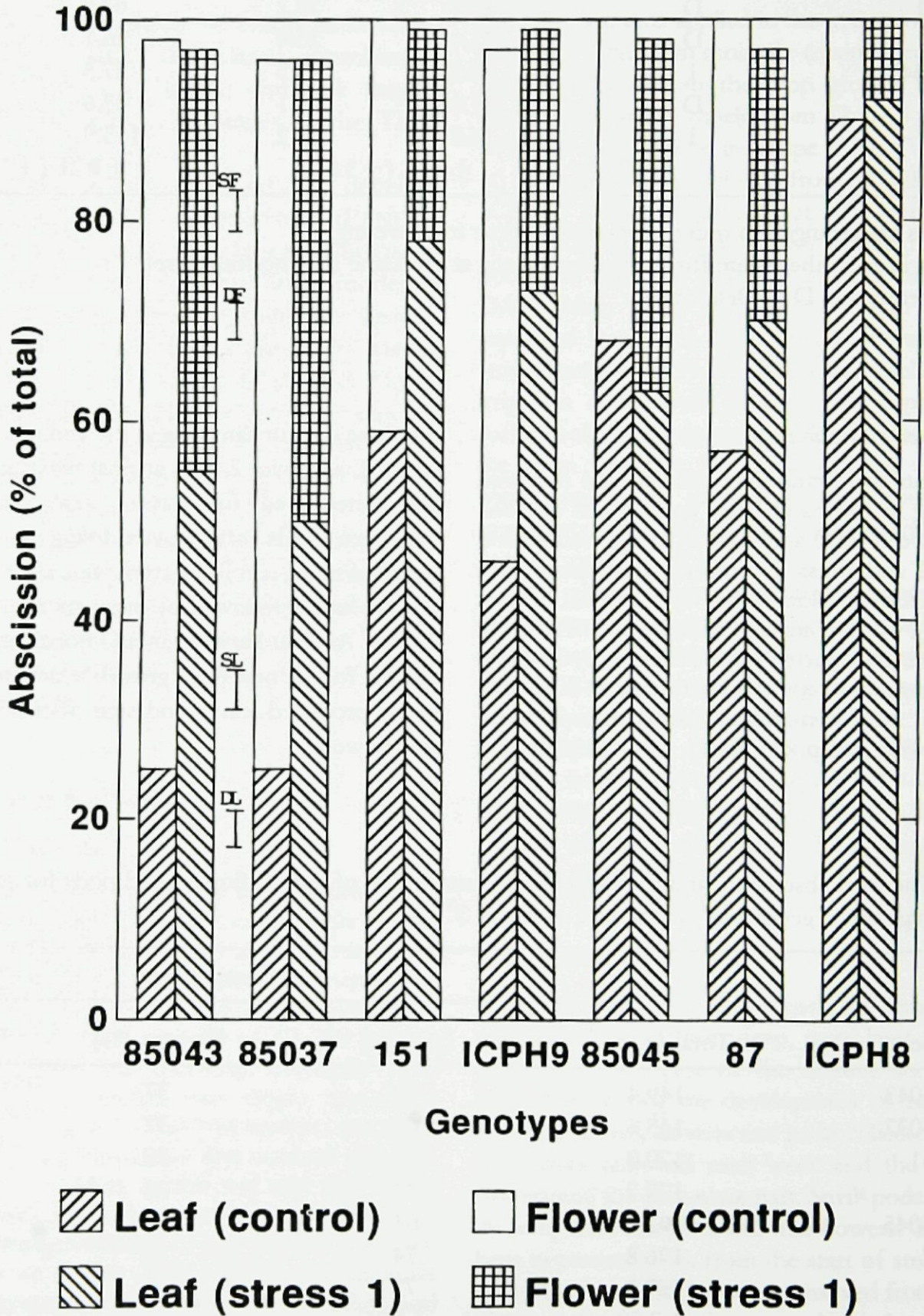


Fig. 1. Effects of stress 1 on the abscission (% of total) of leaves and flowers (the remainder representing pods) at 88 days after sowing for seven short-duration pigeonpea genotypes. Genotypes are arranged from left to right in order of increasing time to 50% flowering. Standard error bars for comparisons of flowers (F) or leaves (L) at the same (S) or different (D) soil moisture levels are indicated

Results

Total abscission

At the end of stress 1 and stress 2, the total cumulative abscission (leaf, flower and pod; g m^{-2}) in control plots was lower for determinate compared to indeterminate genotypes (Table

1). For control plots from the end of stress 1 (88 DAS) to the end of stress 2 (102 DAS), there was 3- to 4-fold increase in the total cumulative abscission. Total abscission was not significantly affected by stress 1, but tended to increase especially for the determinate genotypes. Stress 2 significantly increased total abscission for all

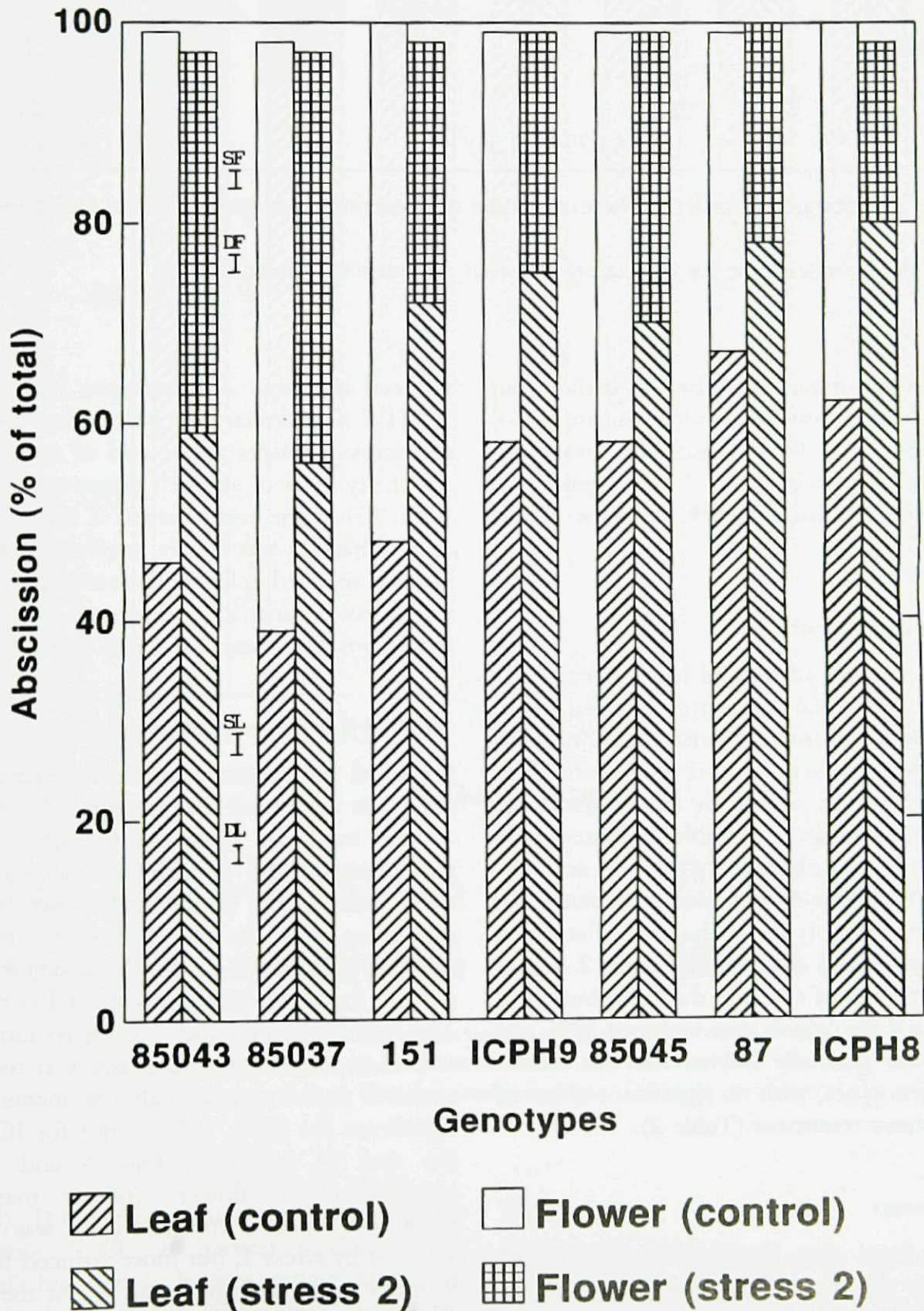


Fig. 2. Effects of stress 2 on the abscission (% of total) of leaves and flowers (the remainder representing pods) at 102 days after sowing for seven short-duration pigeonpea genotypes. Relative time to 50% flowering of genotypes, and error bars are as indicated for Fig. 1

Table 3. The effects of soil moisture treatments on the shoot dry mass (g plant^{-1}) of seven short-duration pigeonpea genotypes¹ at the end of stress 1 and stress 2

Genotype	Stress 1 (52–88 DAS)		Stress 2 (78–102 DAS)	
	Control	Stressed	Control	Stressed
ICPL 85043	17.1	11.4	14.4	15.1
ICPL 85037	14.1	12.2	16.6	11.7
ICPL 151	16.7	11.8	21.6	19.8
ICPH 9	15.2	12.3	20.5	13.0
ICPL 85045	16.3	12.8	20.2	14.4
ICPL 87	16.7	13.9	16.6	9.8
ICPH 8	21.1	18.7	24.5	18.6
SE	$\pm 1.79 (\pm 1.56)^2$		$\pm 1.85 (\pm 1.78)^2$	

¹Genotypes are arranged in order of increasing time to flowering, their growth habits are as indicated in Table 1

²SE values in parentheses are for comparing means at the same soil moisture level

determinate genotypes and for the earliest but not for the later flowering indeterminate genotypes (Table 1). Total abscission was not significantly affected by stress 3 for all genotypes and data were pooled for each genotype (Table 2).

Abscission components

Leaves and flowers accounted for between 95% and 100% of the total dry matter abscised for all genotypes under all soil moisture conditions, with the remainder representing pod abscission which was not significantly altered by any of the water stress treatments (Figs 1, 2; Table 2). Water stress increased the contribution of leaves and decreased that of flowers to total abscission for early flowering genotypes at the end of stress 1, and for all genotypes at the end of stress 2 (Figs 1 and 2). At the end of stress 3, the contribution of leaves to total abscission was between 59% and 76% and was generally lowest for the earliest flowering genotypes, with no significant effect of the water stress treatment (Table 2).

Shoot dry mass

Shoot dry mass was significantly reduced by stress 1 only for the earliest flowering genotype (ICPL 85043), and was least affected for this genotype by stress 2 (Table 3). For later flowering genotypes (ICPH 9, ICPL 85045, ICPL 87 and ICPH 8), shoot dry mass was significantly

reduced by stress 2. Genotypes ICPL 151 and ICPH 9 had similar shoot dry mass for control and stressed plants at the end of stress 1, while shoot dry mass of stressed plants was greater for ICPL 151 at the end of stress 2. Shoot dry mass at final harvest was largely unaffected by stress 3 but was reduced in line with seed yield reductions for stress 1, and in addition to harvest index reductions for stress 2 (LOPEZ et al., 1996).

Shoot dry mass partitioning

Under all soil moisture treatments, leaves, stems and pods accounted for between 90% and 100% of the total dry mass. Water stress induced reductions in the contribution of leaves (leaf mass ratio; LMR) at the end of stress 1 were significant only for the determinate genotypes ICPL 151 and ICPL 87 (Fig. 3), and at the end of stress 2 for all genotypes, except ICPH 8 (Fig. 4). The contribution of pods (pod mass ratio; PMR) tended to increase by water stress at the end of stress 1 and stress 2, with the increase being significant for ICPL 151 but not for ICPH 9 at the end of stress 1 (Figs 3 and 4). The contribution of flowers (flower mass ratio; FMR) for these two genotypes was similarly affected by stress 1, but more reduced for ICPH 9 under stress 2 (Figs 3 and 4). At the time of final harvest, the PMR was reduced only by stress 2 with genotype ICPL 151 being least affected, while the LMR tended to increase under both stress 1 and stress 2 and decrease under stress 3

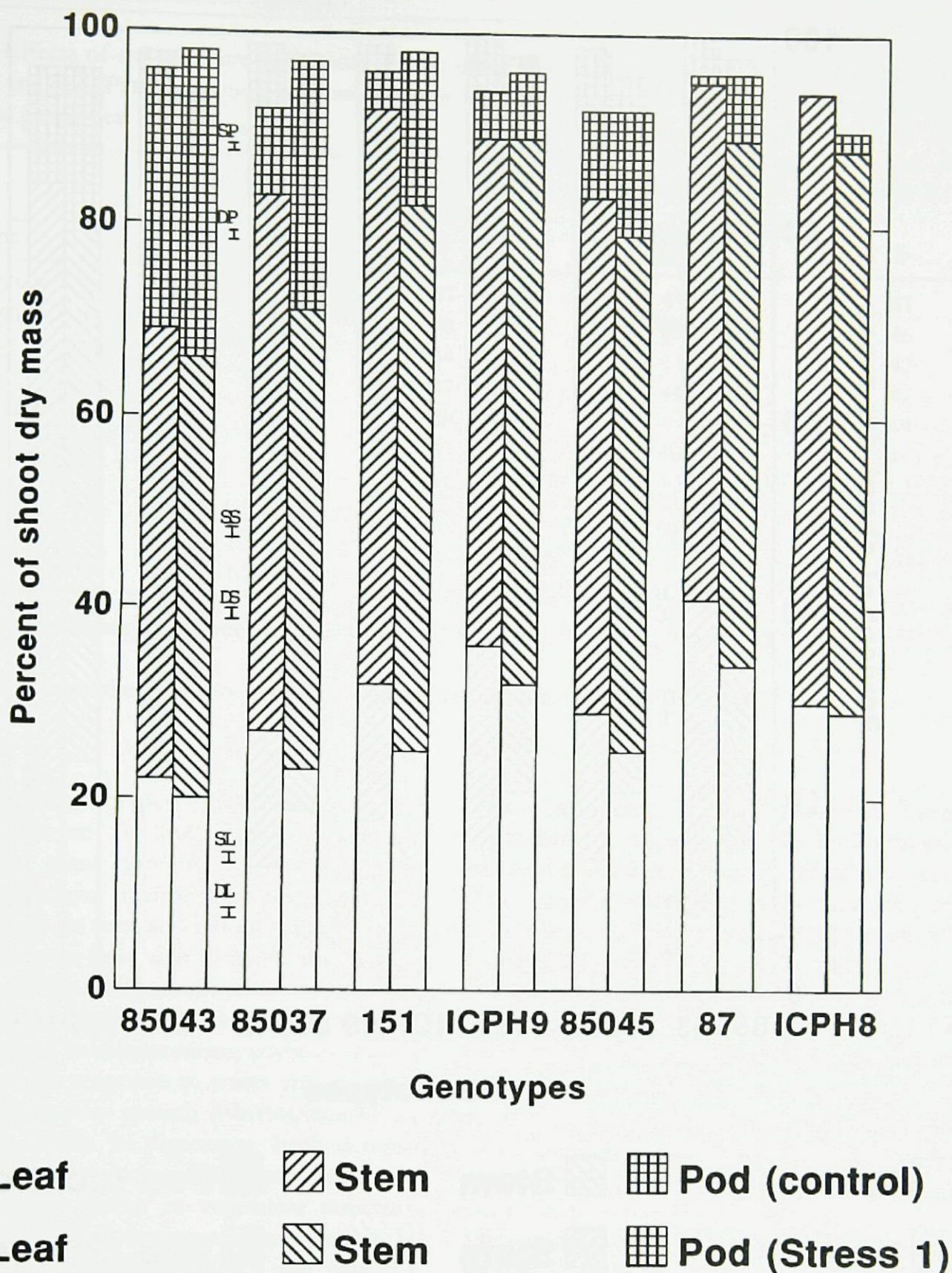


Fig. 3. Effects of stress 1 on the shoot dry mass partitioning (% of total) into leaf, stem and pod (the remainder representing flowers) at the end of stress 1 for seven short-duration pigeonpea genotypes. Relative time to 50% flowering, and error bars for comparing leaf (L), stem (S) and pod (P) are as indicated for Fig. 1

(Table 4). The contribution of new growth (new mass ratio; NMR) at harvest tended to be increased by stress 1 for earlier flowering genotypes (ICPL 85043, ICPL 85037 and ICPL 151), and by stress 2 for later flowering genotypes, and reduced by stress 3 for most genotypes (Table 4).

Discussion

The timing of drought stress application influenced the total dry mass and the relative contribution of various components of both the abscised plant material and the remaining (intact) shoot. At the end of stress 1 and stress 2, the

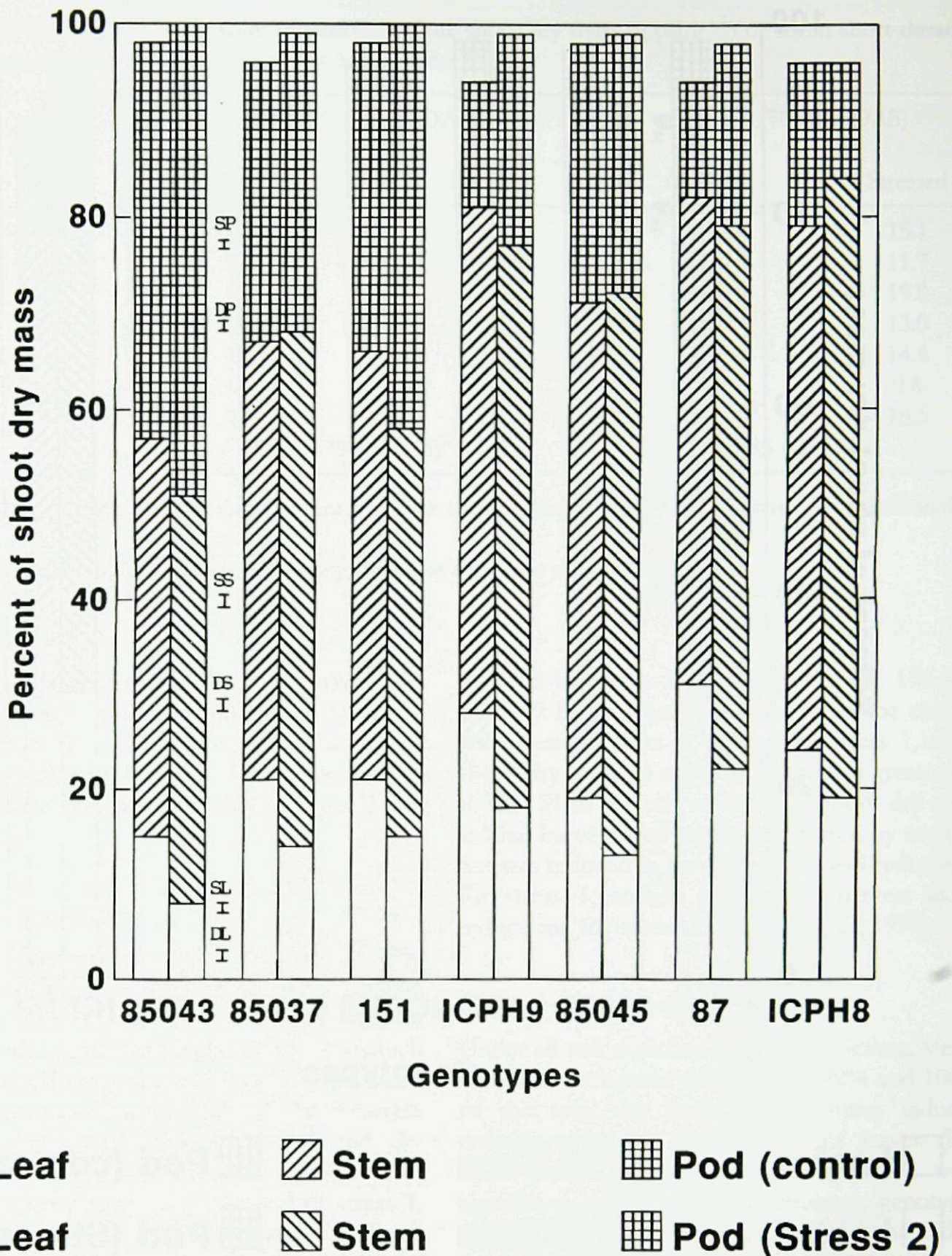


Fig. 4. Effects of stress 2 on the shoot dry mass partitioning (% of total) into leaf, stem and pod (the remainder representing flowers) at the end of stress 2 for seven short-duration pigeonpea genotypes. Relative time to 50% flowering, and error bars for comparing leaf (L), stem (S) and pod (P) are as indicated for Fig. 1

total cumulative dry mass of fallen plant material in control plots was lower for determinate compared to indeterminate genotypes, but increased to a greater extent for the determinate genotypes under water stress. Greater total abscission in indeterminate genotypes may result from continued vegetative growth during repro-

ductive development leading to greater competition among developing structures, and also a more rapid remobilization of nutrients from older leaves. Under water stress, vegetative growth is more reduced than reproductive growth (MECKEL et al., 1984; ONG, 1984), so that the abscission levels of the determinate approach those of the

Table 4. Effects of soil moisture treatments on the shoot dry mass partitioning (% of total) into leaf (L), stem (S), and pod (P; the remainder representing new flush growth) at final harvest for seven short-duration pigeonpea genotypes¹

Genotype	Control			Stress 1			Stress 2			Stress 3		
	L	S	P	L	S	P	L	S	P	L	S	P
ICPL 85043	3	40	52	3	37	51	2	47	47	2	41	55
ICPL 85037	5	44	49	8	38	47	7	51	39	3	46	49
ICPL 151	4	43	50	7	34	48	7	43	46	4	42	54
ICPH 9	4	38	56	4	37	54	6	44	46	3	42	55
ICPL 85045	2	45	51	2	38	57	5	49	41	2	49	47
ICPL 87	6	40	52	10	37	50	10	40	45	4	46	49
ICPH 8	5	45	44	6	41	50	9	52	30	4	52	43
SE	L	$\pm 0.8 (\pm 0.8)^2$										
	S	$\pm 2.0 (\pm 1.9)$										
	P	$\pm 2.7 (\pm 2.6)$										

¹Genotypes are arranged in order of increasing time to flowering, their growth habits are as indicated in Table 1

²SE values in parentheses are for comparing means at the same soil moisture level

indeterminate genotypes, which may be less affected because of the reduced vegetative demand for plant nutrients. Compared to the other water stress treatments, stress 2 had the greatest effect on total abscission, suggesting that the plant may be least able to meet sink demand under this water stress treatment.

The lack of competing sinks in semi-determinate compared to indeterminate soybean allows a more favorable response to water stress applied during reproductive growth (NEYSHABOURI and HATFIELD, 1986). In pigeonpea, both determinate and indeterminate genotypes can continue to accumulate dry matter in vegetative structures after the start of flowering and comparable HI values are observed (SHELDRAKE and NARAYANAN, 1979; SHELDRAKE, 1984). Total abscission levels were high for the indeterminate hybrid ICPH 8, and were similar for the determinate hybrid ICPH 9, and ICPL 151, indicating that this parameter cannot be used to separate genotypes on the basis of drought resistance. The indeterminate genotype, ICPL 85045, had the highest dry mass of fallen plant material at harvest, about 200 g m^{-2} , which is slightly lower than that reported for medium-duration genotypes (SHELDRAKE and NARAYANAN, 1979).

The contribution of pods (length > 20 mm) to the dry mass of fallen plant material was small and not significantly affected by any of the water

stress treatments for all genotypes. Yield of short-duration pigeonpea under both rainfed and irrigated conditions is greatly affected by internal plant conditions existing at the time of pod set and early pod development (LOPEZ et al., 1994). In addition, the only yield component that decreases significantly under water stress is the number of pods m^{-2} (LOPEZ et al., 1996), suggesting that the degree of yield stability under water stress conditions is determined largely during pod set and early pod development. For medium-duration pigeonpea under rainfed conditions, abscised pods account for only 2% of the fallen material by the time of harvest (SHELDRAKE and NARAYANAN, 1979). Continued seed growth in soybean under water stress (MECKEL et al., 1984) is supported by mobilization of reserves stored in vegetative structures (WESTGATE et al., 1989), and by the preferential maintenance of seed water status compared to that of the remaining shoot (WESTGATE and GRANT, 1989).

The contribution of leaves to the total dry mass of abscised plant material generally increased and that of flowers decreased in response to water stress during early reproductive growth. Therefore, changes in abscission under water stress at this stage favor a reduction in the capacity of the source relative to that of the reproductive sink, although the latter may already

be in excess under conditions of adequate soil moisture (LOPEZ et al., 1994). In pigeonpea, flower production is excessive (SHELDRAKE, 1984) and production of flowers destined to abscise may represent an inefficient use of source capacity. Reduction in flower abscission under water stress may be due to reduced flower production, as occurs for faba bean (*Vicia faba*; HEBBLETHWAITE, 1982). Stress 3 did not significantly influence abscission components for all genotypes indicating a strong resistance to changes in the source/reproductive sink ratio during late reproductive growth. Maintenance of source capacity under water stress and reduction in the imbalances between source and reproductive sink sizes, possibly by reducing flower production and competition from vegetative sinks, are likely to result in improved drought resistance.

The responses of shoot dry mass of intact plants to water stress varied with the stage of development, with the late vegetative and the pod-fill stages being comparatively unaffected and the late flowering and early pod development stages more affected. In faba bean, shoot dry mass has a very low sensitivity to water stress during flowering and pod fill compared to other growth parameters (HUSSAIN et al., 1990), while for other grain legumes grown under an irrigation gradient, shoot dry mass is linearly related to the amount of water applied (PANDEY et al., 1984). The shoot dry mass was similar for genotypes ICPL 151 and ICPH 9 under stress 1, but the ICPL 151 had a higher dry mass at the end of stress 2. Since the total abscission levels under stress conditions were similar for these two genotypes, genotypic differences in the drought responses may have been due to differences in dry mass partitioning under stress and/or in the rate of recovery after water stress was relieved. In soybean, compensatory shoot growth rates occur during recovery from water stress (HOOGENBOOM et al., 1987), and in cowpea there is rapid recovery of shoot growth following water stress periods in the vegetative stage (TURK and HALL, 1980), with new flushes of flowering produced when water stress is relieved at later growth stages (TURK et al., 1980; LAWN, 1982).

The LMR was most affected by water stress for two determinate genotypes at the end of stress 1, and was least affected for an indeterminate genotype (ICPH 8) at the end of stress 2, suggesting that indeterminate genotypes may be better able to maintain LMR under water stress.

Since the contribution of leaves to total abscission generally increased under the stress treatments, the maintenance of LMR will require continued leaf production and/or reduced partitioning of dry mass into other shoot components. For ICPL 151, the LMR was more reduced and PMR more increased under stress 1 than for the hybrid ICPH 9. An apparent promotion of pod production under mild water stress also occurs for other grain legumes (WIEN et al., 1979; TURK and HALL, 1980; ONG, 1984), and may be due to the differential effects of water stress on vegetative and reproductive growth rates (ONG, 1984).

Since the PMR and shoot dry mass were similar or greater for ICPL 151 compared to ICPH 9 at the end of the stress treatments, differences in the yield responses to drought were most likely due to differences in pattern of recovery after water stress was relieved. A high PMR at the end of water stress during early pod development possibly inhibits production of new growth flushes and further pod set, which reduces the ability for yield recovery even if soil moisture becomes non-limiting at later growth stages. In soybean, the shedding of distal flowers is induced by substances produced in more proximal developing pods (HUFF and DYBING, 1980), while in pigeonpea, the presence of developing pods may reduce the levels of assimilates and/or nutrients below the threshold required for further pod set (SHELDRAKE, 1979, 1984). At the end of stress 2, most genotypes were in the early pod development stage, and seed yield was most affected under this water stress treatment (LOPEZ et al., 1996). The maintenance of source capacity (by reduced leaf abscission and/or continued production) during water stress periods and the rapid recovery of dry mass and pod production following stress during early pod development, may lead to improved drought tolerance in short-duration pigeonpea.

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Zusammenfassung

Einfluß des Einwirkungszeitpunktes von Dürrestreß auf den Abwurf und die Trockenmasseverteilung frühreifender Taubenerbsen

Die Sproßtrockenmasse-Aufteilung und das kumulative Abwerfen von Blättern, Blüten und Hülsen wurden bei 9 frühreifen Taubenerbsen-Genotypen untersucht, wobei eine Anzucht unter angemessener Bodenfeuchtigkeit während des gesamten Wachstums (Kontrolle) verglichen wurde mit Wasserstreß während der späten vegetativen und Blühphase (Streß 1), während der Blüte und der frühen Hülsenentwicklungsphase (Streß 2) und während der Hülsenfüllungsphase (Streß 3). Die gesamte kumulative Trockenmasse abgeworfener Pflanzenteile war geringer bei Genotypen mit determiniertem Wuchs, erhöhte sich aber in einem größeren Ausmaß unter Wasserstreßbedingungen als bei den indeterminierten Genotypen, wobei Streß-Gruppe 2 und Streß-Gruppe 3 die geringsten Auswirkungen zeigten. Der Trockenmasseanteil der Hülsen am Gesamtabwurf war <5% und wurde nicht signifikant durch Wasserstreß beeinflusst, während der Anteil der Blätter zunahm und der Anteil der Blüten abnahm. Streßbehandlung 3 hatte keine signifikanten Auswirkungen auf den Abwurf an Gesamttrockenmasse oder einzelner Teilen der Pflanze. Die Reduktion in der Sproßtrockenmasse unter Wasserstreß war deutlicher für Genotypen während der frühen Hülsenentwicklung, während die Trockenmasseanteile der Blätter grundsätzlich abnahmen und diejenigen der Hülsen zunahmen unter den Streßbedingungen 1 und 2. Bei vergleichbaren Abwurfmengen erwies sich die Sproßtrockenmasse des Genotyps ICPL 151 als gleich oder höher als die der Hybride ICPH 9 unter Streßbedingungen 1 und 2; der Anteil der Hülsen an der Sproßtrockenmasse war geringer bei der Hybride ICPH 9 unter beiden Streßbehandlungen. Genotypische Differenzen in der Trockenheitsresistenz sind wahrscheinlich eine Folge der Unterschiede in der Blattflächendauer während und in der Erholungsphase der Trockenmasse- und Hülsenproduktion, die auf Wasserstreßbedingungen folgten.

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