The importance of second flushes of flowers in mungbean production

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ABSTRACT

This paper reports results from six sowings of mungbean where treatments were imposed to give a range of timing and severity of water deficit. The intention of the trials was to improve understanding of the factors influencing the occurrence of second flush of flowers and quantify the contribution of second flush to total grain yield. The relative contribution of the second flush to total yield was highest where crops were stressed during mid-vegetative development and subsequently relieved at early flowering, and these were crops that also had the highest harvest index. The second flush was poorer or absent under terminal water stress. The occurrence of a large second flush was not able to fully compensate for yield losses associated with a small first flush. Lowered grain quality of the first flush while waiting for maturity of the second flush was related to the cumulative amount of rainfall after the maturity of the first flush.

Key words:

Mungbean, second flush.

INTRODUCTION

Mungbean (*Vigna radiata*) is a short-season summer grain legume grown predominantly under dryland conditions in the north-eastern grains region of Queensland. Due to the erratic nature of summer rains and variation in stored soil water at sowing, the crop is exposed to varying timing and severity of water deficit, which results in variability in grain yield, nitrogen accumulation and grain quality. While vegetative growth in mungbean declines at the onset of the reproductive phase, the crop is able to produce a second flush of flowers if conditions are favourable. While this characteristic provides some degree of yield compensation (2), it does predispose the crop to grain weathering damage if harvest is delayed. The quantitative contribution of the second flush of flowering to final grain yield is not well known. Most information on the second flush phenomenon is descriptive (1), where the occurrence of the second flush is documented without any quantitative analysis.

Grain quality is an important determinant of price in mungbean grain and is strongly influenced by weather damage during pod filling (4). In situations where a small first flush of yield is produced and there is relief from water deficit, there are good prospects for a large second flush yield. However, the mungbean grower is faced with the decision of whether to wait for the second flush to mature before harvesting and hence risk weather damage on both flushes of pods, or to harvest the first flush yield only. A quantitative understanding of the factors influencing second flush occurrence may help with the design of optimal management strategies in relation to climatic risk for mungbean production.

This paper reports on the results of six sowings of mungbean where crops were exposed to a range of timings and severities of water deficit. The crops were analysed for growth and development with the aim of improving the understanding of those factors that control the size of the second flush of pods and its contribution to overall yield.

MATERIALS AND METHODS

Mungbean cv. Emerald was sown on six occasions over two seasons on a deep alluvial weakly cracking vertisol (Typic Chromostert) at Lawes, South East Queensland (27.33?S, 152.20?E, elevation. 150m) (Table 1).

Table 1. The effect of sowing dates and water regimes on total grain yield, size of second flush and it's contribution to total yield for mungbean cv. Emerald in the six sowings at Lawes, Qld. Approximate timing of water stress in relation to crop development is indicated.

Sowing date	Water regime	Timing of water stress	Total grain yield (g m^{-2})	Grain yield from second flush (g m^{-2})	% contribution of second flush to total yield
28 Nov 1996	Well-watered		292	79	27
	Rainfed + irrig	Late veg to early podfill	281	177	63
	Rainfed	Late veg to early podfill	148	74	50
7 Jan 1997	Well-watered		225	*	-
	Rain shelter	Sowing to maturity	125	0	0
	Rainfed	Flowering to maturity	38	0	0
3 Dec 1997	Well-watered		302	63	21
	Rain shelter	Flowering to late podfill	123	58	47
	Rainfed	Late pod-fill to maturity	245	59	24
17 Dec 1997	Well-watered		244	24	10
	Rain shelter	Late veg to mid pod-fill	148	70	47
	Rainfed	Mid pod-fill to	197	14	7

		maturity			
30 Dec 1997	Well-watered		224	52	23
	Rain shelter	mid veg to early flowering	168	94	56
	Rainfed	Early pod-fill to maturity	187	2	1
16 Feb 1998	Well-watered		218	68	31
	Rainfed + irrig	mid-veg to mid podfill	215	82	38
	Rainfed	mid-veg to mid podfill	172	64	37

*can not be determined due to less frequent sampling

Water regimes were imposed by varying the timing and amount of irrigation. In four of the sowings (2-5) a rain shelter was used to exclude rain during certain periods of crop development. Well-watered conditions were maintained by applying 35 mm irrigation per week when rainfall was negligible or low. Inoculated seeds of cv. Emerald were sown at 37.5 cm row spacing, to give a population of 40 plants m^{-2}. All sowings had four replications. Crops were hand sampled for grain yield and biomass (1 m^2 quadrat) at regular intervals throughout crop growth. The numbers of flowers, green (immature) and black (mature) pods were recorded at frequent intervals on 4 tagged plants per plot. The dates of flowering and physiological maturity were recorded when 50% of plants in a plot achieved that stage. Maturity of pods from first and second flushes occurred when 95% of pods were black. The size of the second flush was estimated by subtracting final grain yield from grain yield at maturity of the first flush. In sowings 3-6, shed leaves were recovered at weekly intervals and their dry weight used to correct harvest index calculations. Grain quality (3) was assessed using 200 seeds per plot. All wrinkled, cracked, discoloured, mouldy and germinated seeds were classified as weathered.

RESULTS AND DISCUSSION

Flower and pod number dynamics

Figure 1 shows how the timing of water stress influences the dynamics of flower and pod number production. Two distinct peaks of flower and immature (green) pod numbers can be seen, and consequently two phases of the production of black (mature) pods.

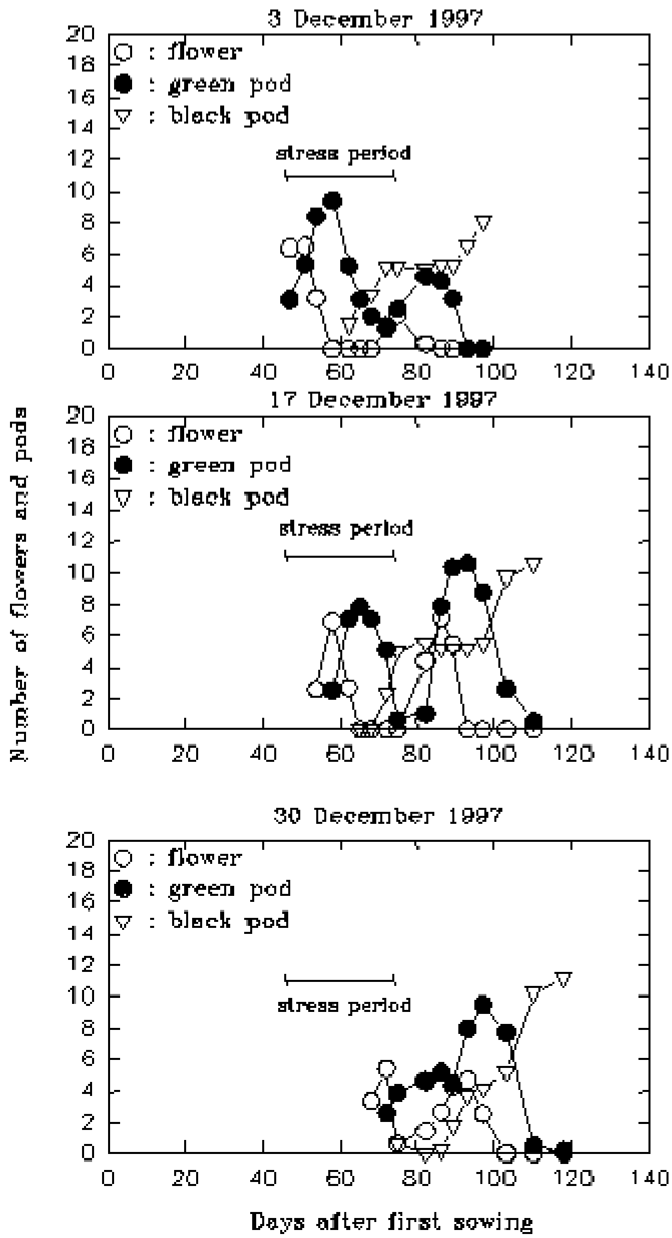

Figure 1. Dynamics of flower, green (immature) and black (mature) pods on tagged plants for three sowings where the period of water stress was manipulated through the use of a rain shelter. The approximate period of stress is indicated.

When stress occurs after the onset of flowering and then relieved during early pod-filling, such as in the third sowing, there is a larger second peak of flowers and pods produced. With later occurrence of stress such as in sowings 1 and 2, which intrude further into pod filling, the second peak becomes less pronounced and consequently the second flush of pods contributes less to the final total pod number.

Grain yield

The 18 environments that the crops were exposed to generated a wide variation in grain yield from 38 to 302 g m^{-2} (Table 1). The size of the second flush and its contribution to total yield was associated with the timing and relief of water stress. In environments where the crop experienced terminal water stress (eg 7

Jan 1997 sowing, rainfed treatment) the contribution of the second flush was negligible. However, where water stress was imposed during the vegetative phase and then relieved before early pod-filling (eg 17 Dec 1997, rainshelter treatment), the size of the second flush was considerable. The second flush in the well-watered crops contributed between 10-30% to final yield, however this was nearly always exceeded by a larger second flush and larger contribution to final yield by a corresponding water stress treatment in that sowing. Hence, well-watered conditions alone were not sufficient to produce a large second flush and some level of mid-season water stress was necessary to create the conditions for a large second flush in absolute and percent contribution terms. Across the 18 environments there was a significant negative correlation between size of first flush and size of the second flush, although the slope was –0.27 indicating that crops with small first flushes still yielded lower in total. Hence, the ability of mungbean to produce second flushes of flowers in response to relief from mid-season stress does not provide a mechanism for complete compensation of yield losses from water stress.

There was also some evidence that crops that produced a large proportion of their total yield from the second flush had more efficient partitioning of dry matter to grain (Fig. 2).

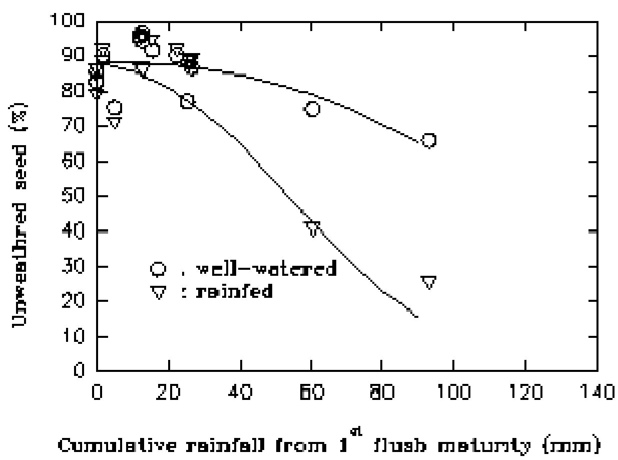

Figure 2. Relationship between harvest index at maturity of the second flush and the relative contribution of the second flush to final yield. Each point is a treatment listed in Table 1.

Grain quality

Fig. 3 shows the relationship between the percent unweathered grain and the cumulative rainfall after the maturity of the first flush. The relationship confirms that found by others (4) but surprisingly it indicates that there is an influence of water stress on grain quality *per se*, with the rainfed crop having lower quality that the irrigated for moderate and high rainfall amounts.

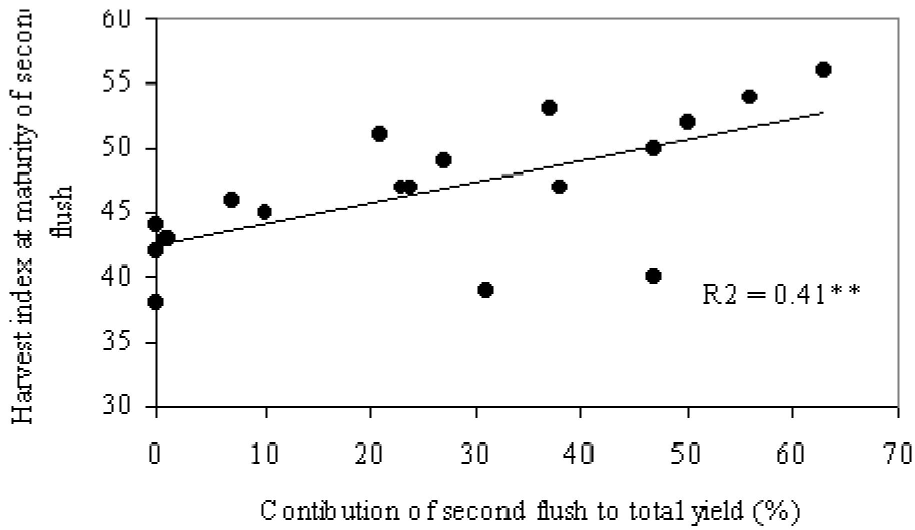

Figure 3. Relationship between percent unweathered grain and cumulative rainfall following the maturity of the first flush. Separate regression relationships are shown for irrigated and rainfed crops.

CONCLUSION

This study has shown that the contribution of the second flush to final yield can be considerable, especially where mid-season stress is relieved at early pod-filling. The capacity to produce a second flush of pods does not compensate fully for yield losses, and there is a risk of weathering damage when waiting for the second flush to mature. This information, especially when combined in simulation models and coupled with long term climate data, can be used to design optimal management strategies for the crop.

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