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EFFECT OF FLOODING ON VEGETATIVE AND REPRODUCTIVE GROWTH OF GROUNDNUT

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Keywords: Groundnut, Flooding effect, Yield reduction.

RINGKASAN

Kacang tanah varieti Matjam dibanjiri air pada beberapa peringkat tumbesaran. Keputusan menunjukkan kesan banjir amat serius antara 42 dan 78 hari selepas ditanam dan berkurangan sebelum dan selepasnya. Banjir selama tujuh hari pada 49 dan 56 hari selepas ditanam boleh mengakibatkan kematian pokok.

INTRODUCTION

Groundnut is one of the most important legume crops grown in Malaysia. It is presently grown in river-flood plains, single-crop paddy areas or as an intercrop under young rubber and oil palm. In all cases, it is grown under rainfed condition and as such is planted on, or soon after, the onset of the rainy season. Temporary waterlogging often occurs in farmers' plots, not only over restricted areas but also over the entire fields, and this is because of either the uneven local topography or the physical nature of the soil. This problem is more regularly encountered in single-crop paddy areas.

Many legumes are sensitive to waterlogging (MASEFIELD, 1957; HEINRICHS, 1970; MINCHIN and SUMMERFIELD, 1975). In cowpea, waterlogging has been reported to reduce nodule production, accelerate senescence of the lowermost leaves and delay branch formation (HONG, MINCHIN and SUMMERFIELD, 1977). Four days of waterlogging on pea resulted in chlorosis of foliage, lower rates of transpiration, reduced number of fruiting nodes and extension of internodes (JACKSON, 1979). The effect of waterlogging varies with plant age. Studies by JACKSON (1979) on pea indicated that flowering plants at the 9- to 10-leaf stages were more severely damaged than young vegetative plants bearing only two to three leaves.

This study attempts to identify the sensitivity stages of groundnut to flooding under pot condition. The effects of flooding duration on plant performance and yield are also quantified.

MATERIALS AND METHODS

In Experiment I, groundnut seeds (Matjam variety) were sown in black polythene bags (15 cm x 23 cm) filled with soil mixture in the ratio of 3:2:1 of top soil:sand:peat. After two weeks, three uniform seedlings were selected and transplanted into each of the 50 cm diameter pots (60 cm high) filled with top soil (Munchong series). These seedlings were left to re-establish for another two weeks before the flooding treatments were imposed. Flooding was imposed by plugging the side drainage holes of the pots with rubber stoppers. The water level was maintained at 7 cm above the soil surface. Flooding was imposed for a duration of seven days at nine growth phases as follows:

T1 – control (no flooding)
T2 – 28 days after sowing
T3 – 35 days after sowing
T4 – 42 days after sowing
T5 – 49 days after sowing
T6 – 56 days after sowing
T7 – 63 days after sowing
T8 – 70 days after sowing
T9 – 77 days after sowing
T10 – 84 days after sowing

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In Experiment II, the groundnut seeds (Matjam variety) used were pregerminated. Three planting holes were made in each of the 50 cm diameter pots (60 cm high) filled with top soil (Munchong series). Two seeds were planted at each point and thinned to one seedling per point a week later. Flooding up to 7 cm above the soil surface was imposed at four growth stages as follows:

T1 – control (no flooding)
T2 – 42 days after sowing
T3 – 54 days after sowing
T4 – 66 days after sowing
T5 – 78 days after sowing

At each of the stages, flooding was imposed for a duration of five and ten days, giving a total of nine treatments (including one control).

In both experiments, Randomized Complete Block Design was used with each treatment replicated five times. Fertilizers in the form of urea (0.04 g/kg soil), triple superphosphate (0.06 g/kg soil) and muriate of potash (0.05 g/kg soil) were supplied at three and six weeks after planting.

The plants were harvested at 100 days after sowing (DAS). Each plant was separated into leaves, stems, roots, pegs, pods and seeds, and their oven-dried (at 80°C for two days) weights recorded. The total number of dead plants, fresh and rotten pods, seeds and seedlings at harvest were also recorded. Data were analysed using the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

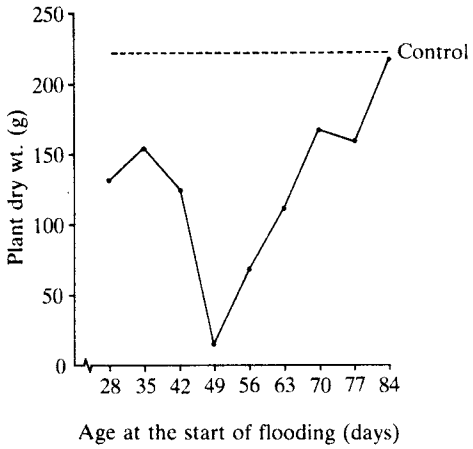
In Experiment I, visual observations indicated that the effect of flooding varied with crop age. Seven days of flooding, beginning at 28 and 35 DAS, resulted in stunted plants while at later stages the leaves turned yellow followed by wilting. The wilting was most serious when flooding began at 49 DAS, resulting in the death of most of the treated plants. This was reflected by the significantly lower number of plants at harvest in T5 *(Table 1)*. A similar trend was noted in Experiment II where plants subjected to five and ten days of flooding at 42, 54, 66 and 78 DAS showed yellowing of leaves followed by wilting. The effect was more serious after ten days of flooding, especially at 54 and 66 DAS, when most of the treated plants were dead. This was reflected by the lower number of plants at harvest in T3 and T4 *(Table 2)*. All plants that were subjected to five days of flooding recovered.

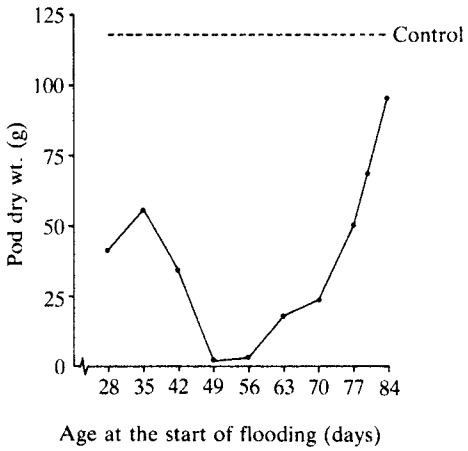
Figure 1 shows the effects of flooding on plant, pod and seed dry weights, and the number of pods and seeds. Generally, flooding reduced the values of these

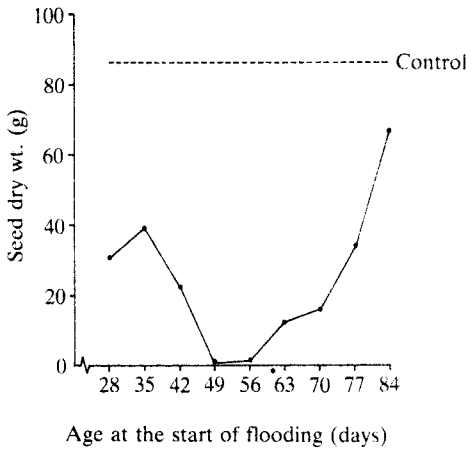
Table 1. Effect of seven days of flooding at various developmental stages on some vegetative and reproductive parameters of groundnut (Experiment I)

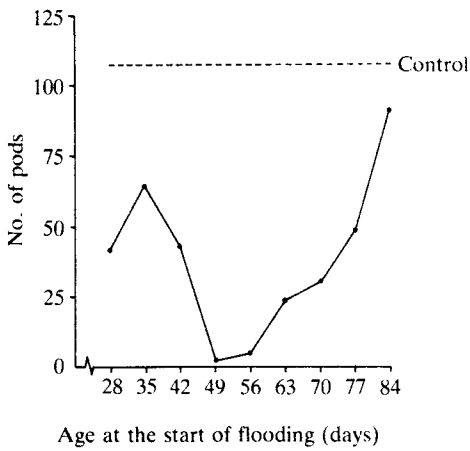
Treatment	No. of plants	No. of rotten pods	No. of seedlings at harvest	Dry weight (g)			
				Leaf	Stem	Root	Rotten pod
T1 (Control)	2.4a*	1.2c	0.0c	39.6a	43.7bc	5.9a	0.2d
T2 (28 days after sowing)	2.8a	1.4c	0.0c	40.7a	38.1bc	3.8ab	0.3d
T3 (35 days after sowing)	2.6a	3.0c	0.0c	44.9a	40.1bc	5.8a	0.4d
T4 (42 days after sowing)	2.8a	0.0c	0.0c	41.1a	38.9bc	3.9ab	0.0d
T5 (49 days after sowing)	0.6b	2.4c	0.0c	4.9c	7.2d	0.1c	0.3d
T6 (56 days after sowing)	2.2a	28.8b	1.6c	20.1b	31.5c	0.7c	8.2c
T7 (63 days after sowing)	2.2a	48.6a	8.6bc	32.5a	43.6bc	0.8c	14.9b
T8 (70 days after sowing)	3.0a	52.2a	59.6a	38.6a	61.4a	2.0bc	31.7a
T9 (77 days after sowing)	2.2a	23.2b	13.0b	33.1a	50.1ab	1.7bc	15.9b
T10 (84 days after sowing)	2.6a	15.6bc	0.0c	37.8a	61.2a	4.9a	7.2c

*Similar subscripts within the same column indicate no significant differences at P = 0.05.
Values in ( ) indicate the start of flooding.









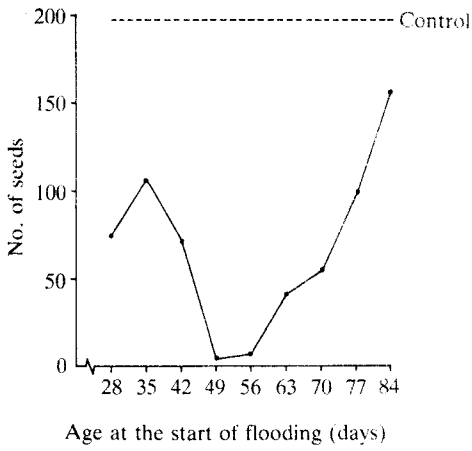
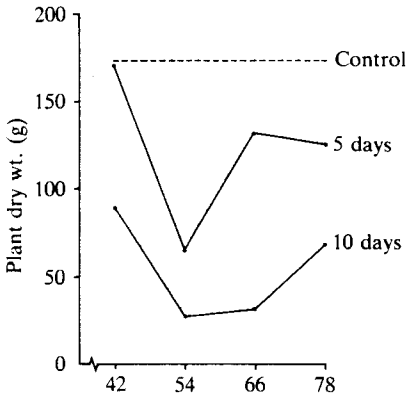
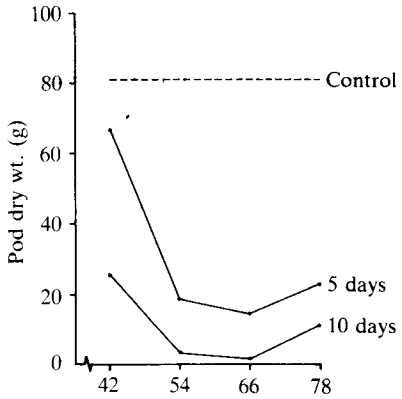


Figure 1. Effect of flooding at different growth stages on some vegetative and reproductive parameters (Experiment I).



Age at the start of flooding (days after sowing)



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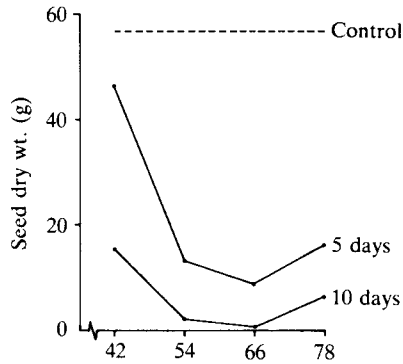

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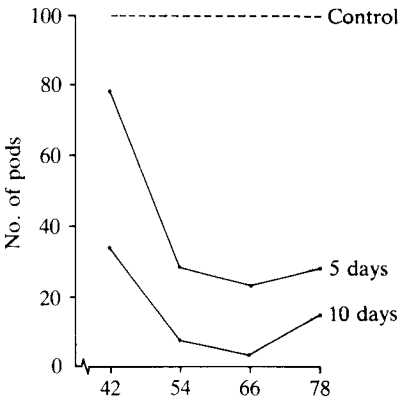

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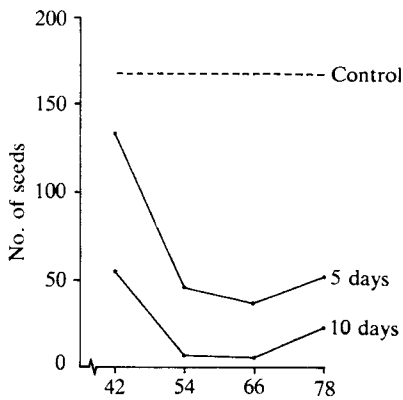

Age at the start of flooding (days after sowing)

Figure 2. Effect of flooding at different growth stages on some vegetative and reproductive parameters (Experiment II).

Table 2. Effect of flooding at various developmental stages on some vegetative and reproductive parameters of groundnut (Experiment II)

Treatment	No. of plants	No. of rotten pods	No. of seedlings at harvest	Dry weight (g)			
				Leaf	Stem	Root	Rotten pod
T1 (Control)	3.0a*	2.3ab	1.0b	38.0a	43.9a	2.3a	1.2b
T2 (42 days after sowing)	2.6a	1.3b	4.4b	34.9a	36.9a	2.2a	1.9b
T3 (54 days after sowing)	1.1c	1.4b	0.1b	12.1b	18.5b	0.4b	0.3b
T4 (66 days after sowing)	1.5bc	5.2ab	3.0b	26.6a	37.2a	1.1ab	2.4b
T5 (78 days after sowing)	1.9b	6.3a	18.6a	28.8a	36.4a	1.4ab	9.7a

Values for all parameters are means over the 2 flooding durations.
*Similar subscripts within the same column indicate no significant differences at P = 0.05.
Values in ( ) indicate the age at the start of flooding.

parameters over that of the control. A reduction in values of these parameters was also observed in the growth phases *(Figure 1)*. The effect of flooding became more severe with age, reaching a maximum between 49 and 56 DAS, but decreased at later stages. A similar result was obtained in Experiment II where flooding of five and ten days between 42 and 78 DAS reduced the plant, pod and seed dry weights, and the number of pods and seeds over the control *(Figure 2)*. The effects of waterlogging on these parameters were again lowest in the earlier stages, reaching a maximum between 54 and 66 DAS after sowing *(Figure 2)*. The varied responses of plants at different growth phases to waterlogging had been reported in pea by JACKSON (1979) where very young pea plants were found to be relatively tolerant to waterlogging.

Flooding for seven or more days at any stage between 28 and 77 DAS could reduce the seed yield by more than 50% while flooding between 42 and 70 DAS could reduce the seed yield by more than 70% *(Figure 3)*. From *Figure 4*, it can also be seen that five days of flooding between 54 and 78 DAS and ten days of flooding between 42 and 78 DAS could reduce the seed yield by more than 50% and 70% respectively. The effects of waterlogging in reducing crop yield were also reported by KAWASE (1981). In cowpea, it had been reported that plants exposed to three periods of waterlogging, each of four-day duration, during vegetative growth reduced the seed yield by more than 50% (HONG *et al.*, 1977).

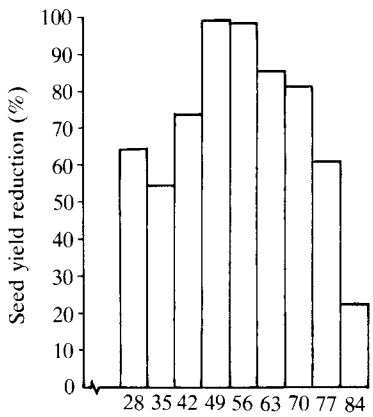

Figure 3. Seed yield reduction as a result of flooding in Experiment I.

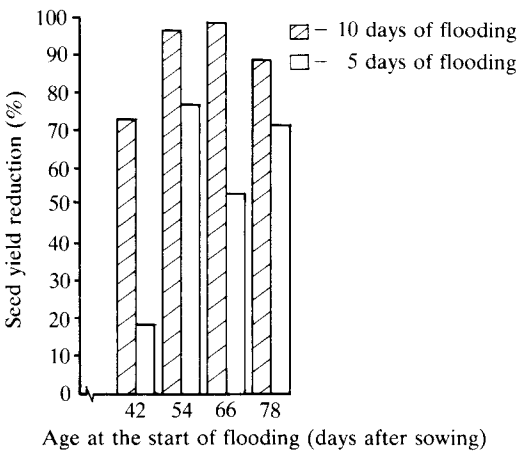

Figure 4. Seed yield reduction as a result of flooding in Experiment II.

The reduced seed yield of the flooded plants was related to the low number of pods and seeds, a result of poor plant performance *(Figures 1* and *2)*. In the early growth stages (up to 49 DAS), the yield reduction was probably because of reduced pod production, as seen from the lesser number of rotten pods. The effect of waterlogging in reducing the number of fruiting nodes was also reported by JACKSON (1979). At later stages, yield reduction might have been partly the result of a large number of rotten pods *(Table 1)*. There was also a higher incidence of germinated seeds in the pods if flooding occurred at the later stages as was reflected by the high number of seedlings at harvest *(Tables 1* and *2)*.

Flooding around 49 and 56 DAS *(Table 1)*, and 54 DAS *(Table 2)* affected the leaf, stem and root dry weights significantly. All these had led to a significant reduction in total plant dry weight *(Figure 1)*. The effect of waterlogging in reducing the dry weights of vegetative parts had also been reported in pea (JACKSON, 1979).

From *Figure 2,* it can be seen that five days of flooding at critical stages such as 54 and 66 DAS reduced the dry weights and number of plants, pods and seeds significantly. Increasing the flooding duration from five to ten days intensified the weight reduction, although less significantly than those from zero to five days. Work by JACKSON (1979) showed that the final fresh and dry weights of both the pods and vegetative parts of the pea were reduced severely after two days of waterlogging. An increase in waterlogging duration from two to three or four days generally reduced the values of these parameters further, although not significantly. He also found that one day of waterlogging was sufficient to reduce shoot dry weight by 18 per cent.

CONCLUSION

It was proven that groundnut, at any growth stage, was sensitive to flooding. The effects, however, varied with the phases of plant development. They were most serious between 42 and 78 DAS (a period which partly coincided with the rapid pod-filling stage), and were less before and after this period. It is, therefore, important to regulate the time of planting such that the most sensitive stage does not occur during a rainy season, especially in areas which are prone to waterlogging or even flooding. Planting may be done on raised beds. A more lasting measure would be to provide drainage for the area.

The reaction of a very young groundnut plant (below four weeks old) to flooding is not known. Further work is, therefore, necessary to identify the degree of yield loss if flooding occurs during earlier growth stages and the effects of shorter flooding durations. This information is necessary in deciding whether it would be more economical to retain a crop of groundnut or plough it and replant with another crop. These studies showed that even a week of flooding at 28 DAS could reduce seed yield by 65 per cent. It is, therefore, worthwhile to consider the economic of maintaining a crop with poor yield to maturity.

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ABSTRACT

Groundnut, Matjam variety, was subjected to flooding at various growth phases. Results indicated that effect of flooding varied with phases of plant development. The effect was most serious between 42 and 78 days after sowing, and less serious before and after this period. Seven days of flooding at 49 and 56 days after sowing can be detrimental to the plants.

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