PHYSIOLOGICAL STUDIES OF RATOONED AND NON-RATOONED WINGED BEAN GROWN WITH AND WITHOUT SUPPORT

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Abstract

Support systems and ratooning had a significant and overriding influence on the pattern of dry matter, nitrogen (N) accumulation and their partitioning and consequently the seed yield compared with the control. Although non ratoon plants grown on a 2 m support height accumulated greatest total dry matter and total N/plant, ratooning at 19 WAG grown on the same height produced highest cumulative seed yield. Plants grown on 2 m support height with ratooning at 19 WAG recorded the highest cumulative seed yield (6.26 t/ha), largely associated by high net photosynthetic efficiency, leaf dry matter and leaf N. The results also indicated that winged bean plants grown on a 2 m support height as ratoon crop is technologically feasible and viable. Non ratoon plants grown on a support height of 2 m lagged behind those ratooned at 19 and 22 WAG under same support height in respect of cumulative seed yields over three crop cycles. The lowest cumulative seed yield (1.28 t/ha) was obtained from unsupported control plants under ratooning at 25 WAG.

Key words: Ratooned, support, winged bean.

Winged bean [*Psophocarpus tetragonolobus* (L.) DC.] is an annual or perennial legume which needs support for good growth and seed production. The support system involves a major portion of production cost and it is one of the major constraints of intensive production of winged bean. There is little information available on the effect of support systems on seed yields of winged bean (2) and there is no experimental evidence on how the increased seed yield was achieved by ratooning approach. Therefore, this experiment was designed to investigate the feasibility of ratooning of winged bean and accumulation of dry matter and nitrogen in relation to seed yield in winged bean grown on support systems and ratooning practices.

Materials and Methods

The experiment was conducted during January 1996 to January 1997 at the Universiti Putra Malaysia Farm, Serdang, Malaysia. All cultural practices followed by (2). After harvesting of mature pod existing plant materials and support structures were used for executing ratooning schedule. The plants were cut at a height of about 30 cm above from the ground surface (*ie*. 8 –10 node contain in old plant stock) in each treatment according to ratooning schedule. After completion of one ratoon cycle the main plant was cut again for next ratoon cycle (*ie*. 2nd ratoon). Plant was cut at 10 - 12 node above from old stock.

The experiment consisted of three levels of support systems and four levels of ratooning schedule. The support systems consisted: (i) unsupported control; (ii) supported in 1-m wire trellis; and, (iii) supported in 2-m wire trellis; Ratooning consisted: (i) without ratooning (control); (ii) ratooning done at 19 WAG; (iii) ratooning done at 22 WAG; and, (iv) ratooning done at 25 WAG. The experiment was laid out in a split plot design with four replications. Support systems and ratooning schedules were placed in the main and sub-plot respectively. Total dry matter and whole plant N was determined by (1) and (2). Seed yield data was also recorded. The data were subjected to statistical analyses, appropriate for the experimental design using the Statistical Analysis System (4).

Results

Dry matter and N accumulation per plant increased with advancing of crop age. Non-ratoon plants recorded higher N accumulation and the rate of N accumulation trend exactly followed the similar pattern

of dry matter accumulation. The additive rate of biomass and N accumulation in whole plant were significantly affected by support systems, ratooning and their interaction effects. Non ratoon plants grown on a support height of 2 m gained supremely good biomass (Fig. 1) and total N accumulation (Fig. 2). Unsupported plants with ratooning at 25 WAG showed poor performance on biomass and N accumulation. While non-ratoon plants grown on support height of 1 m and ratooning at 19 or 22 WAG plants grown on support height of 2 m recorded moderate total dry matter and N accumulation (Fig. 1 and 2). The rate of dry matter and N accumulation was slow during the initial stages of crop growth in unsupported plants compared with supported height of 1 and 2 m.

The relative contribution of nitrogen accumulation among plant organs also varied among the plants grown on support systems, ratooning and their interaction effects. During vegetative stages N partitioned in leaves ranked first (57 –71%), stems and petioles were second (19 – 32%) and third (10 – 13%). The highest (71 %) leaves N was obtained in ratooning at 19 WAG under support height of 2 m and non ratoon unsupported plants recorded the poorest (57%). Nitrogen contents in leaves and petioles declined by 21 - 48%, and 6 - 7% during the reproductive phase. Out of total N per plant the pods gained 22 - 58% (Fig. 3). During the reproductive phase, there was a greater decline in leaves N (48 %), moderate decline in petioles N (7%) and least decline in stems N (4%) for plants ratooning at 19 WAG under support systems of 2 m in height.

Ratooning at 22 or 25 WAG under support height of 2 m contributed moderate leaves and pods N. Ratoon and non-ratoon unsupported plants contributed moderate and the lowest proportion of leaves, and petioles N towards grain formation, respectively (Fig. 3). Irrespective of support systems contribution of leaves N at vegetative and pods N at reproductive phases was higher in ratoon plants compared with non-ratoon plants. Stem N contribution was not observed at all in case of unsupported plants irrespective of support systems (Fig. 3). The petioles N did not show any significant variation among the treatments at both vegetative and reproductive phases.

In this experiment three cycle of winged was grown and individual crop cycle yield and cumulative seed yield has been shown in the Fig. 4. Cumulative seed yield is a combination of main crop yield (*ie*. before execution of ratooning schedule) plus ratoon first cycle and second ratoon cycle. Support systems, ratooning and their interaction effects showed significant variation among the individual crop cycle and cumulative seed yield. Plants grown on support height of 2 m with ratooning at 19 WAG recorded the highest cumulative seed yield (6.26 t / ha). Non-ratoon plants grown on a support height of 2 m lagged behind those ratooned at 19 and 22 WAG under same support height in respect of cumulative seed yield over three crop cycle (Fig. 4). Plants grown on support height of 2 m with ratooning at 22 WAG ranked second in respect of cumulative seed yield. Plants grown on support height of 1 m with ratooning at 19 and 22 WAG produced better yield compared with non-ratoon and ratooning at 25 WAG under same support height. The lowest cumulative seed yield (1.28 t /ha) was obtained from unsupported control plants with ratooning at 25 WAG. The better yield was obtained from main crop as well as ratoon crop cycle in case of supported crops but the yield of ratooning at 19 or 22 WAG was better than non-ratooned in case of unsupported plants (Fig. 4).

Discussion

The results indicated that N accumulation was directly dependent on total dry matter per plant. Irrespective of support systems, non-ratoon plant dominated over ratoon plant in respect of both dry matter and N accumulation. Nitrogen contents in above ground plant parts decreased consistently from the onset of flowering, with a rapid decrease from the start of pod filling until maturity. At the vegetative stage, 57 - 71% of total plant nitrogen was partitioned to the leaf, which confirms the results of (3) and (2). In this study, leaves and petioles N declined during pod filling period. Thus, contribution of leaves N was greater, moderate in petioles and lowest in stems towards grain formation in supported plants. Although contribution of leaves and petioles N was observed in unsupported plants but there was no contribution of stems N towards grain N was found. Although non-ratoon plants accumulated more total N but distribution in leaves N and contribution towards grain was a poor compared with ratoon crops. These results indicate that N partitioning towards grain is more important similar to dry matter partitioning. Contribution of N was much higher during grain formation and N distribution towards grain was probably

satisfactory. The proportion of grain N varied between 22 to 58%. It was assuming that concentration of grain N is related to the amount of N available for re-distribution rather than the plant's ability to continue N_2 fixation during pod filling. In fact, decline in leaves N was associated with grain development as well as senescence of leaves due to aging in all types of plants.

Non-ratoon plants averaged over the support systems produced identical yield from main crop and subsequent first crop cycle but drastically decreased in the next (second) ratoon cycle due to poor growth performance. Ratooning at 19 WAG produced satisfactory yield from main crop, ratoon first cycle and significantly the highest yield from ratoon second cycle compared with other treatments (Fig. 4). Non ratoon plants grown on a support height of 2 m lagged behind those ratooned at 19 and 22 WAG under same support height in respect of cumulative seed yield over three crop cycle. Support height of 1 m plants with ratooning at 19 and 22 WAG produced better yield compared with non ratooning and ratooning at 25 WAG under same support height (Fig. 4). The lowest cumulative seed yield was obtained from unsupported control plants with ratooning at 25 WAG. In main crop cycle pods per plant was identical in respective treatment because of unimplemented of ratooning schedule. When ratooning schedule executed in the second crop cycle (1st ratoon cycle) and continued for third cycle (2nd ratoon cycle) pods per plant varied significantly. Non ratoon plants could not be able to produce more pods due to source limitation. In fact the highest cumulative seed yield was achieved by the contribution of second ratoon crop cycle.

Conclusion

Indeterminate climbing winged bean grown on a support system can accumulate more biomass and N compared with unsupported plants. It is concluded that in addition to dry matter accumulation, partitioning of leaves N plays an important role in vegetative growth and seed yield of winged bean. Seed production of supported plants can be increased by adopting with a support height of 2 m over unsupported plants and a large saving in the cost of staking or construction of supports can be realized by ratooning practices. Increas-ed seed production with physiological processes associated with the cultural practice of providing support system of 2 in height. Optimum time of ratooning (19th weeks after germination) under support system of 2 m in height can maximize yield per unit area per year with reducing initial cost of trellising spread over three crop cycles.

References

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