Dry Matter Production and Yield Performance of Summer and Winter Pulses in Bangladesh

Matsunaga, Ryoichi
Laboratory of Crop Science, Faculty of Agriculture, Kyushu University

Hamid, Abdul
Institute of Postgraduate Studies in Agricultute

Hashem, Abul
Institute of Postgraduate Studies in Agricultute

https://doi.org/10.5109/23932

出版情報：九州大学大学院農学研究院紀要. 33 (3/4), pp.221-228, 1989-03. Kyushu University

J. Fac. Agr., Kyushu Univ., 33 (3•4), 221-228 (1989)

Dry Matter Production and Yield Performance of Summer and Winter Pulses in Bangladesh

Ryoichi Matsunaga, Abdul Hamid* and Abul Hashem*

Laboratory of Crop Science, Faculty of Agriculture,
Kyushu University, Fukuoka 812, Japan.

(Received September 30, 1988)

The capability of dry matter production and seed yield was compared among summer pulses in the monsoon, autumn and summer seasons, and among winter pulses in the winter season in Bangladesh. Summer pulses (soybean, mungbean and cowpea) exerted the highest capability of dry matter production in the monsoon season, but did not have so high seed yield as that in the summer season. Among summer pulses cowpea had the highest maximum-CGR due to the highest LAI, while mungbean had the highest maximum-NAR. Although soybean had as low maximum-CGR as mungbean, its seed yield was always superior to that of mungbean, and to that of cowpea in the monsoon season. Among winter pulses (lentil, chickpea and grasspea) chickpea had both the highest maximum-CGR and seed yield in the winter season. From these results it is difficult to find a direct relationship between growth functions and seed yield. However, the pulse crops which had the highest seed yield in each season always showed steady increase in dry matter after flowering. This suggest the importance of dry matter increase after flowering for high seed yield of pulse crops in Bangladesh.

INTRODUCTION

Pulses are important source of proteins for the people in Bangladesh. However, the farmers prefer growing cereal crops including rice and wheat to pulse crops, due to the higher yield potential and strong consumer demand. Accordingly the seed production of pulse crops has decreased gradually year by year in this country (Plant Breeding Division, BAR1 1980).

For understanding seed productivity of pulse crops, it is important to clear the capability of dry matter production (Nakaseko et ***al.*** 1979). However, agronomic research on pulse crops was directed mainly towards seed yield response to the cultural practices (mixed and intercropping with other crops, sowing time, fertilization, etc.) in this country (BAR1 1981), and there have been few reports on the capability of dry matter production of pulse crops. In this study we compared the capability of dry matter production and seed yield among summer and winter pulses in different seasons.

MATERIALS AND METHODS

Three summer pulses, soybean (*Glycine max* Merr.), mungbean (*Vigna radiata* L.) and cowpea ***(Vigna** unguiculata* Walp.), were cultivated in the monsoon, autumn and

*Institute of Postgraduate Studies in Agricultute, Salna, Gazipur, Bangladesh

Table 1. Experimental conditions.

Pulse/cultivar
: Summer pulse
soybean/Davis, mungbean/No. 7715, cowpea/Felon
: Winter pulse
grasspea/local var., lentil/local var., chickpea/local var.

Growing season/sowing date/pulse
: Monsoon/May 15, 1986/soybean, mungbean and cowpea
: Autunm/Oct. 28, 1986/soybean and mungbean
: Autumn/Nov. 15, 1986/cowpea
: Summer/Mar. 1, 1987/soybean and mungbean
: Winter/Nov. 30, 1986/grasspea, lentil and chickpea

Applied rate of fertilizer
: N 30, P_2O_5 100, K_2O 70 kg/ha (for all pulses)

Plant density/pulse
: 30 x 10 cm (1 plant/hill)
/soybean, mungbean, cowpea and chickpea
: 30 x 5 cm (1 plant/hill)
/grasspea and lentil

summer seasons in an experimental field (brown terrace soil) at the Institute of Postgraduate Studies in Agriculture (IPSA), Salna, Gazipur, Bangladesh. Rice was cultivated in the plots prior to planting the pulses. Winter pulses, grasspea (*Lathyrus sativus* L.), chickpea (*Cicer arietinum* L.) and lentil (*Lens escullenta* Moench), were also cultivated in the winter season in a plot adjacent to the experimental plots of summer pulses. Experiments were conducted using randomized block design with three replications (plot size : 3 X 5 m). Other experimental conditions were shown in Table 1. From 14 or 28 days after sowing (DAS) to the late podfilling stage, plants in a 50 cm-row were taken about two week interval for the determination of dry matter production. The collected plants were divided into each part (leaves, stems+petioles, pods and roots) and dried at 70°C for at least 48 hours. Twenty pieces of leaf disks were punched out from sampled plants by 1 cm-diameter leaf punchers (Kiya Co., KK) and the dry weight of the disks was used for the calculation of specific leaf weight (SLW, cm^2/g). Leaf area index (LAI) was estimated by multiplication of SLW and whole leaf weight at the same sampling date. However, LAI of winter pulses could not ‘be estimated due to their narrow leaves. Crop growth rate (CGR) and net assimilation rate (NAR) were calculated by the procedure of Watson (1952). At maturity stage plants were collected from the center of each plot (1.5 X 3.5 m) for determination of yield performance.

RESULTS

Weather conditions and growth duration of the pulses were shown in Fig. 1. Summer pulses were grown in the conditions of high temperature and large rainfall, low temperature and small rainfall, and high temperature and moderate rainfall in the monsoon, autumn and summer seasons, respectively. Winter pulses were grown in the conditions of the lowest temperature and smallest rainfall.

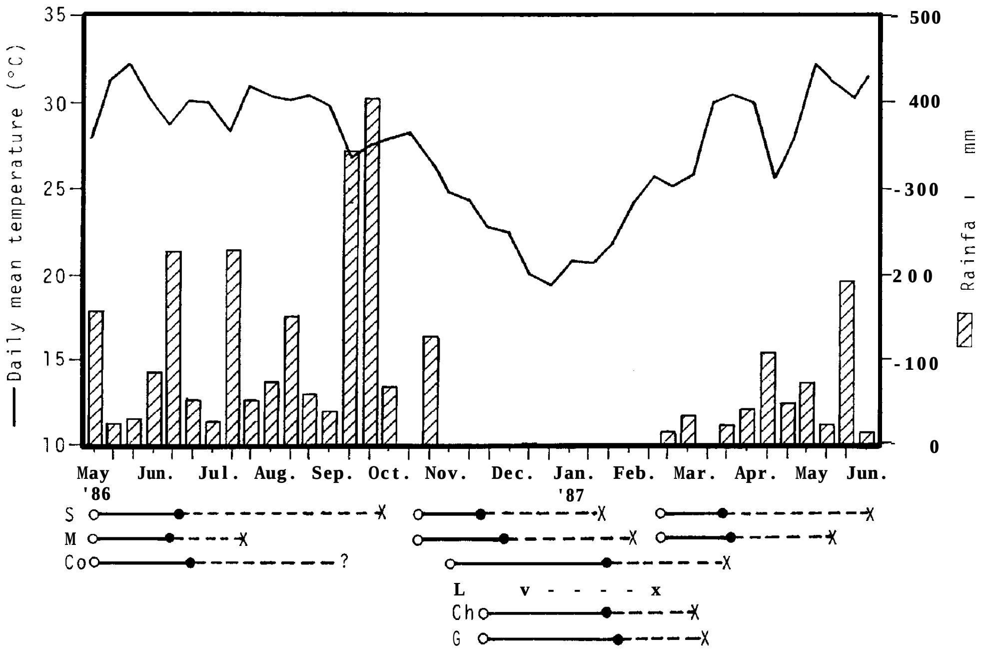

Fig. 1. **Seasonal change** in daily mean temperature and rainfall, and growth duration of summer and winter pulses.
S: soybean, M: mungbean, Co: cowpea, L: lentil, Ch: chickpea,
G: grasspea, o: sowing time, ●: flowering time, x: harvesting time.
Meteorological data were obtained from Bangladesh Agricultural Research Institute.

Summer **pulses**

Dry matter production of cowpea in the vegetative growth stage was higher than that of the other pulses in the monsoon season (Fig. 2A). However, its dry matter stopped increasing after the early podfilling stage (56 DAS), due to the excessive vine growth. Dry matter of mungbean increased until the mid podfilling stage (56 DAS) and decreased rapidly after then, due to the rapid proceeding of reproductive growth. In contrast to the other pulses, dry matter of soybean increased until the last sampling date (108 DAS). LAI of cowpea was much higher than that of the other pulses and reached 10 at the early podfilling stage (56 DAS). LAI of soybean reached maximum of 5.8 at the flowering stage and maintained the same value until 4 weeks after flowering. LAI of mungbean reached maximum of 4.8 at the mid podfilling stage and then decreased rapidly.

Because the growth duration of cowpea was longer than that of the other pulses in the autumn season (Fig. 1), its dry matter continued to increase after the maturity of the other pulses (Fig. 2B). Dry matter of soybean and mungbean increased gradually until last sampling in this season, but was much lower than that of cowpea. LAI of cowpea was higher than that of the other pulses, and increased until mid flowering stage (86 DAS). LAI of soybean increased until the early podfilling stage (47 DAS) and then declined gradually. LAI of mungbean was the lowest among the three pulses

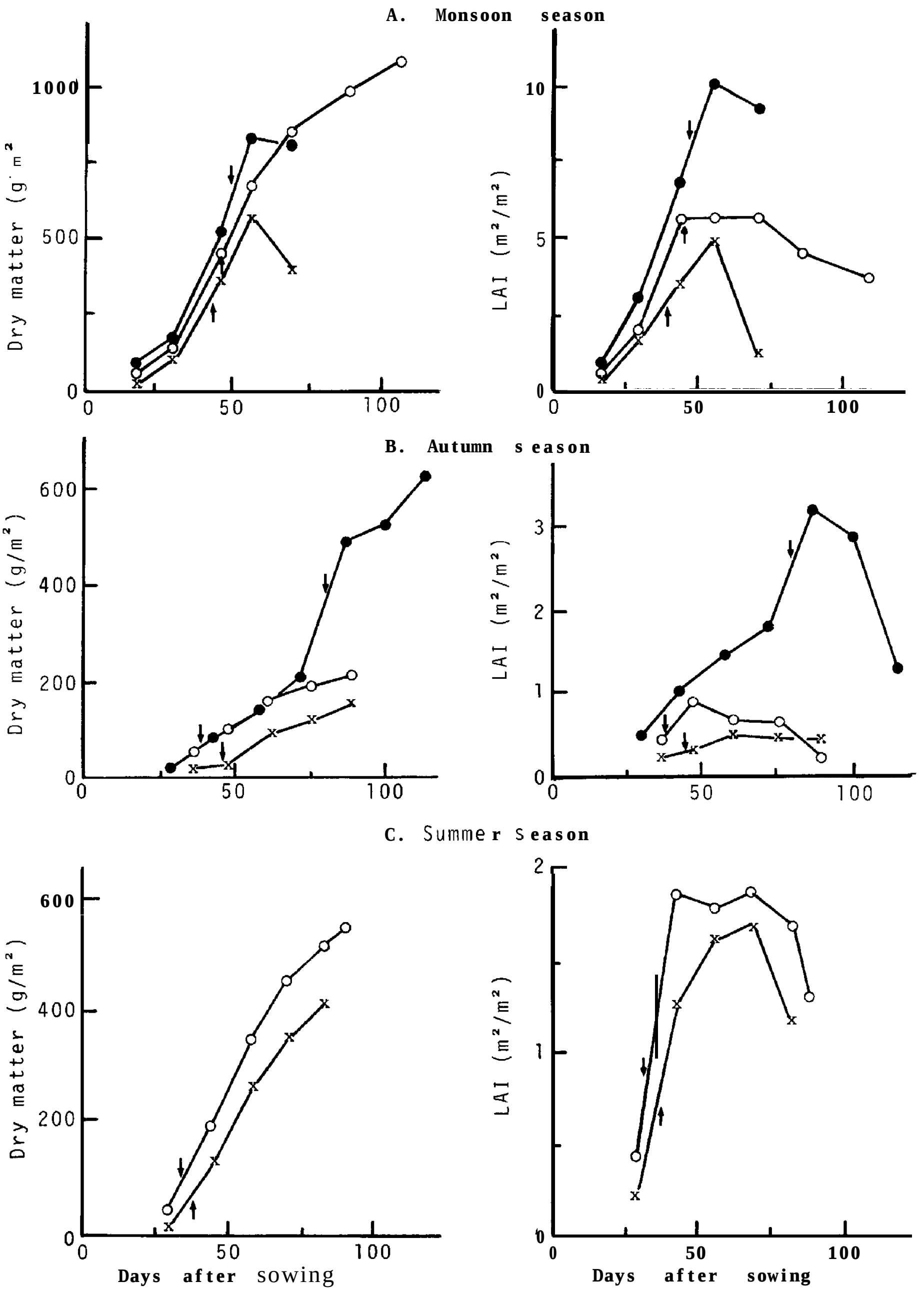

Fig. 2. Seasonal change in dry matter weight and leaf area index (LAI) of summer pulses in different seasons.
o : soybean, x : mungbean, ● : cowpea. Arrows indicate flowering time.

Table 2. Maximum NAR and CGR and their observing growth stage of summer pulses in different seasons.

Season	Pulse	Max. NAR	Growth stage	Max. CGR	Growth stage
Monsoon	Soybean	*10.7*	Early vegetative	20.8	Mid podfilling
	Mungbean	*12.5*	Early vegetative	21.3	Early podfilling
	Cowpea	*8.2*	Early vegetative	25.3	Mid flowering
Autumn	Soybean	6.7	Late flowering	*4.4*	Mid podfilling
	Mungbean	9.7	Late flowering	*3.9*	Late flowering
	Cowpea	7.5	Mid flowering	*18.3*	Mid flowering
Summer	Soybean	*10.2*	Mid flowering	10.5	Early podfilling
	Mungbean	11.0	Mid flowering	9.7	Early podfilling

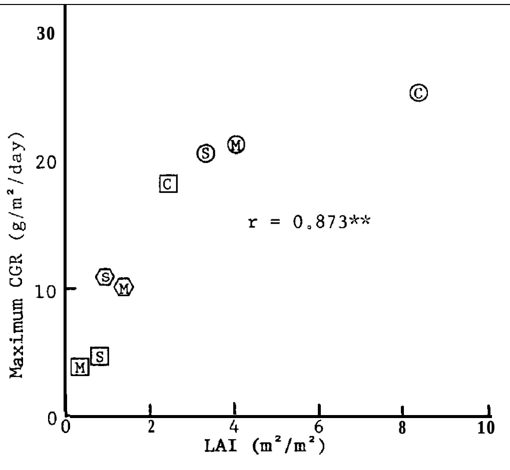

Fig. 3. Relationship between maximum CGR and LAI at the same growth stage.
S : soybean, M : mungbean, C : cowpea, ○ : monsoon season, □ : autumn season, 0 : summer season. **Significant at the 1% level.

Table 3. Seed yield and yield components of summer pulses in different seasons.

Season	Pulse	Seed yield g/m”	No. of pods/m²	Seed size g/100 seeds	Harvest index *
Monsoon	Soybean	110	582	12.9	0.33
	Mungbean	65	339	1.9	0.45
	Cowpea	—			—
Autumn	Soybean	89	420	12.0	2.89
	Mungbean	41	201	2.6	1.96
	Cowpea	148	155	9.3	1.15
Summer	Soybean	230	626	17.5	3.24
	Mungbean	88	1241	2.9	1.68

*Seeds to stem ratio.

except for last sampling date and less than 1 throughout the season.

Dry matter of soybean and mungbean increased until the late podfilling stage, though soybean always had higher dry matter production than mungbean in the summer season (Fig. 2C). LAI of both pulses maintained more than 1 after the flowering till late podfilling stage.

Maximum NAR of the pulses was observed in the vegetative growth stage in the monsoon season, while during the flowering in the autumn and summer seasons (Table 2). Among the pulses mungbean had the highest maximum-NAR. Maximum CGR of soybean and mungbean was observed from late flowering to mid podfilling stage, while maximum CGR of cowpea was observed during the flowering stage. All the pulses had the highest maximum-CGR in the monsoon season. Cowpea had the highest maximum -CGR among the pulses, while soybean and mungbean had similar one in all seasons. Maximum CGR was significantly correlated with LAI at the same period (Fig. 3). However, maximum CGR of cowpea in the monsoon season was not so high for its LAI.

Compared with the other seasons, soybean and mungbean had the highest seed yield in the summer season, due to both the greatest number of pods and the largest seed size (Table 3). Harvest index in this season was also the highest among the three seasons. Seed yield analysis on cowpea was not made in the monsoon season, because the excessive vine growth resulted in poor reproductive growth. However, in the autumn season cowpea had the highest seed yield among the three pulses.

Winter pulses

Dry matter production of grasspea and chickpea increased similarly until late podfilling stage (Fig. 4), though plant density of grasspea was twice as high as that of

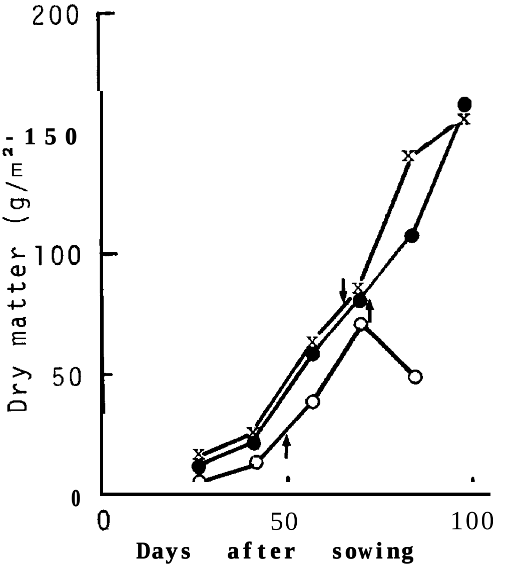

Fig. 4. Seasonal change in dry matter weight of winter pulses in the winter season. o : lentil, x : chickpea, ● : grasspea. Arrows indicate flowering time.

Table 4. Maximum CGR and its observing growth stage of winter pulses.

Pulse	Max. CGR	Growth stage
Lentil	2.3	Early podfilling
Chickpea	4.4	Early podfilling
Grasspea	3.8	Mid podfilling

Table 5. Seed yield and yield components of winter pulses.

Pulse	Seed yield g/m"	No. of pods/m²	Seed size g/100 seeds	Harvest index *
Lentil	23	1095	1.68	1.27
Chickpea	67	565	10.52	1.06
Grasspea	44	475	3.97	0.55

*Seeds to stem ratio.

chickpea (Table 1). Dry matter production of lentil was lower and declined earlier than the other pulses, due to the shorter growth duration (Fig. 1). Maximum CGR was observed during the podfilling stage for all the pulses, and the highest maximum-CGR was for chickpea, followed by grasspea. The lowest maximum-CGR was observed for lentil (Table 4).

Seed yield of chickpea was the highest and that of lentil was the lowest corresponding to their dry matter production (Table 5). However, seed yield of grasspea was not so high for its dry matter production (Fig. 4). So harvest index of grasspea was the lowest among the three pulses.

DISCUSSION

The summer pulses exerted the highest capability of dry matter production in the monsoon season (Fig. 1 and Table 2), but the seed yield was not superior to that in the summer season (Table 3). One of the reasons might be that the cultivars used in this experiment were not adapted to the monsoon season, especially for cowpea which produced few pods on the plants in this season. High rainfall in this season also depressed the normal maturity of pods of the pulses, especially for mungbean. For the agricultural usage of the highest capability of dry matter production of the summer pulses in the monsoon season, it might be necessary to breed the cultivars adapted to this season.

Among the summer pulses cowpea had the highest maximum-CGR, due to the highest LAI (Fig. 3), while soybean had as low as mungbean in each season (Table 2). However, seed yield of soybean was always superior to that of mungbean, and to that of cowpea in the monsoon season (Table 3). Among winter pulses chickpea had both the highest maximum-CGR and seed yield (Tables 4 and 5). From these results it is difficult to find a direct relationship between growth functions and seed yield. However, steady increase in dry matter after flowering and then larger final dry matter accumulation were always observed for the pulses which had the highest seed yield in each season. This suggests the importance of dry matter increase after flowering for high seed yield of pulse crops in Bangladesh.

ACKNOWLEDGEMENTS

This study was supported by the Japan-Bangladesh-United States Technical Cooperation Project. We express our sincere appreciation to all persons concerned with this project, especially Japan International Cooperation Agency (JICA), the major donor of the project.

REFERENCES

BAR1 1981 Proceedings of the national workshop on pulses. A. K. Kaul (ed), Bangladesh Agricultural Research Institute, Joydebpur (Bangladesh), pp. 137-194

Nakaseko, K., K. Gotoh and K. Asanuma 1979 Comparative studies on dry matter production, plant type and productivity in soybean, azuki bean and kidney bean. I. Differences in dry matter accumulation patterns under the low population density. ***Japan. Jour.*** *Crop Sci.*, ***48*** : 82-91

Plant Breeding Division, BAR1 1980 Pulses improvement project annual report 1979-80. Bangladesh Agricultural Research Institute, Joydepur (Bangladesh), pp. 4-13

Watson, D. J. 1952 The physiological basis of variation in yield. In "Advances in Agronomy", Academic Press, New York, 4: 101-145