INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 3, No. 5, p. 135-141, 2013

RESEARCH PAPER OPEN ACCESS

Effect of soil moisture on accumulation and distribution of dry matter in barley (*Hordeum vulgare* L.)

Lipika Ghosh*, M. Anisuzzaman, M. Zahangir Alam, Rafiul Islam

Department of Botany, University of Rajshahi, Rajshahi-6205, Bangladesh

Key words: Accumulation and distribution of dry matter, Barley, Soil moisture regimes.

doi: http://dx.doi.org/10.12692/ijb/3.5.135-141 Article published on May 22, 2013

Abstract

A field experiment was conducted to study the effect of two soil moisture regimes on the accumulation and distribution of dry matter in three cultivars of barley viz, IBON/47, BB-I and KARAN-163. The two soil moisture regimes were irrigated and rainfed control. Soil moisture treatment, cultivar and growth stage had significant effect on leaf, stem panicle and total plant dry weights, except cultivar effect on total plant dry weight. Except a few cases, dry matter accumulation gradually increased with the increasing plant age in both conditions. Distribution of dry matter was significantly greater in stem and pod in the irrigated plants than, in the rainfed plants at most of the stages while that of leaves was greater in the rainfed plants at some of the stages of growth. Among the three cultivars, highest amount of dry matter was found in KARAN- 163. With the advance of plant age, the distribution of dry matter increased in the stem and decreased in the leaf.

* **Corresponding Author:** Lipika Ghosh ✉ lipikag@ru.ac.bd

Introduction

Developmental factors affecting the accumulation of dry matter and subsequent distribution of assimilates are of great importance in determining the final yield in crops (Watson 1971; Wareing and Patric 1975).

Production of barley is affected by many factors in Bangladesh. Soil moisture availability is an important factor for plant growth and development of barley. A number of workers reported significant increase of dry matter by soil moisture application through irrigation 'in a number of crop plants (Krogman and Hobbs 1975 in rape; D' Souza and Coulson 1988 in *Phaseolus vulgaris;* Mondal and Paul 1992 and Begum and Paul 1993 in mustard, Anisuzzaman 2003 and Ghosh 2005 in barley).

Information is limited about the effect of soil moisture requirement on crop growth and development of barley. The objective of this experiment was to study the effect, of soil moisture on accumulation and distribution of dry matter in barley.

Materials and methods

The experiment was conducted in the Botanical Research Field, University of Rajshahi, Rajshahi, Bangladesh with three cultivars of barley viz, IBON/47, BB-1 and KARAN-163. After thorough ploughing, a basal dose of urea (80 kg N/hectare), TSP (40 kg P/hectare) and MP (40 k K/hectare) was added before sowing. There were two treatments: two irrigations were given throughout the cropping period (irrigated); and rainfed (non-irrigated). The first irrigation was applied at 25 days after sowing (DAS) and the second irrigation was at 55 days after sowing. The amount of water was added to moist the surface soil and taken care so that no water logging condition was prevailed. Necessary cultural practices were maintained throughout the growing period. After emergence, seedlings were thinned to get uniform and desirable number of plants.

The experiment included 7 harvests at 10 days interval starting from 30 days after sowing. At each harvest, plant parts were separated into leaf, stem and panicle with grain and dry weights were obtained after drying at 90° C for 48 hours. From the dry weights of different plant parts, distribution of dry matter was calculated. Data were analyzed statistically according to the standard method of analysis of variance of randomized complete block design with three replications.

Results and discussion

Mean squares from the analysis of variance for leaf, stem, panicle and total dry weights of the three barley seed cultivars are given in Table 1. The effects of soil moisture treatments (T), cultivar (C) and growth stage (G) were significant for all the characters; cultivar difference was absent in total plant dry weight. Among the interactions, treatment × cultivar was significant for all the characters except total plant dry weights, treatment × growth stage for all the characters such as leaf, stem, panicle and total plant dry weights, cultivar × growth stage for leaf, panicle dry weight and treatment × cultivar × growth stage for leaf and total plant dry weights.

Dry weights

The changes of dry weights for leaf, stem, panicle and total plant dry weights of three cultivars at successive stages of growth as affected by soil moisture are presented in Figs. 1-4.

Leaf dry matter accumulation

Leaf dry matter of the irrigated plants of all the three cultivars was greater than the rainfed plants (Fig. 1). The leaf dry weight of all cultivars increased up to the 4th harvesting date (60 DAS) and decreased at the later harvesting dates in both treatments but there were a tendency to increase of the rainfed plants than that of the irrigated plants at the last two harvesting dates except IBON/47. At the first harvesting date (30 DAS), KARAN-l63 showed the maximum leaf dry weight under irrigated condition and BB-1 showed the minimum

leaf dry weight under rainfed condition. On the other hand at 60 DAS, KARAN-1 63 showed the maximum leaf dry weight under irrigated condition and IBON/47 showed the minimum leaf dry weight under rainfed condition.

Table 1. Analysis of variance for dry matter yield of three barley cultivars.

Item	DF	Leaf dry weight	Stem dry weight	Panicle dry weight	Total plant dry weight
Treatment (T)	1	13.62**	76.64**	4.01**	209.57**
Cultivar (C)	2	1.37**	1.34**	1.23**	1.48^{ns}
Growth stage (G)	6	5.50**	15.04**	3.91**	31.50**
T × C	2	0.82**	0.85*	0.18*	1.90^{ns}
T × G	6	2.16**	2.08**	0.94**	5.23**
C × G	12	0.80**	0.28^{ns}	0.22**	1.58^{ns}
T × C × G	12	0.76**	0.40^{ns}	0.08^{ns}	2.28**

* and ** indicate significant at *5%* and 1% level, respectively.

Kirby (1969) in barley, Paul and Saha (1998) in wheat and Sivakumar *et al.* (1979) in sorghum also reported that soil moisture increased leaf area. Water stress is known to affect leaf senescence (Asana 1961) and reduces the number of leaves (Sivakumar and Shaw 1978; Turk *et al.* 1980). Wallace and Munger (1965) reported that in grain legumes, leaf area was highest during the early vegetative stage and later decreased rapidly with the advancement of age. Leaf dry weight may be varied due to changes either in leaf area or number or both.

Stem dry matter accumulation

Stem dry weight of the irrigated plants of all the cultivars was much higher than the rainfed plants at all of the growth stages (Fig. 2). The effect of soil moisture on the accumulation of stem dry matter of the three cultivars with the advance of plant age. In all the three cultivars, the effects of soil moisture on stem dry weight were not much pronounced at the early stages but at the later stages, irrigated plants were much pronounced than the rainfed plants. At the later stages of growth, the effect of soil moisture on stem dry weight was prominent in case of KARAN-163.

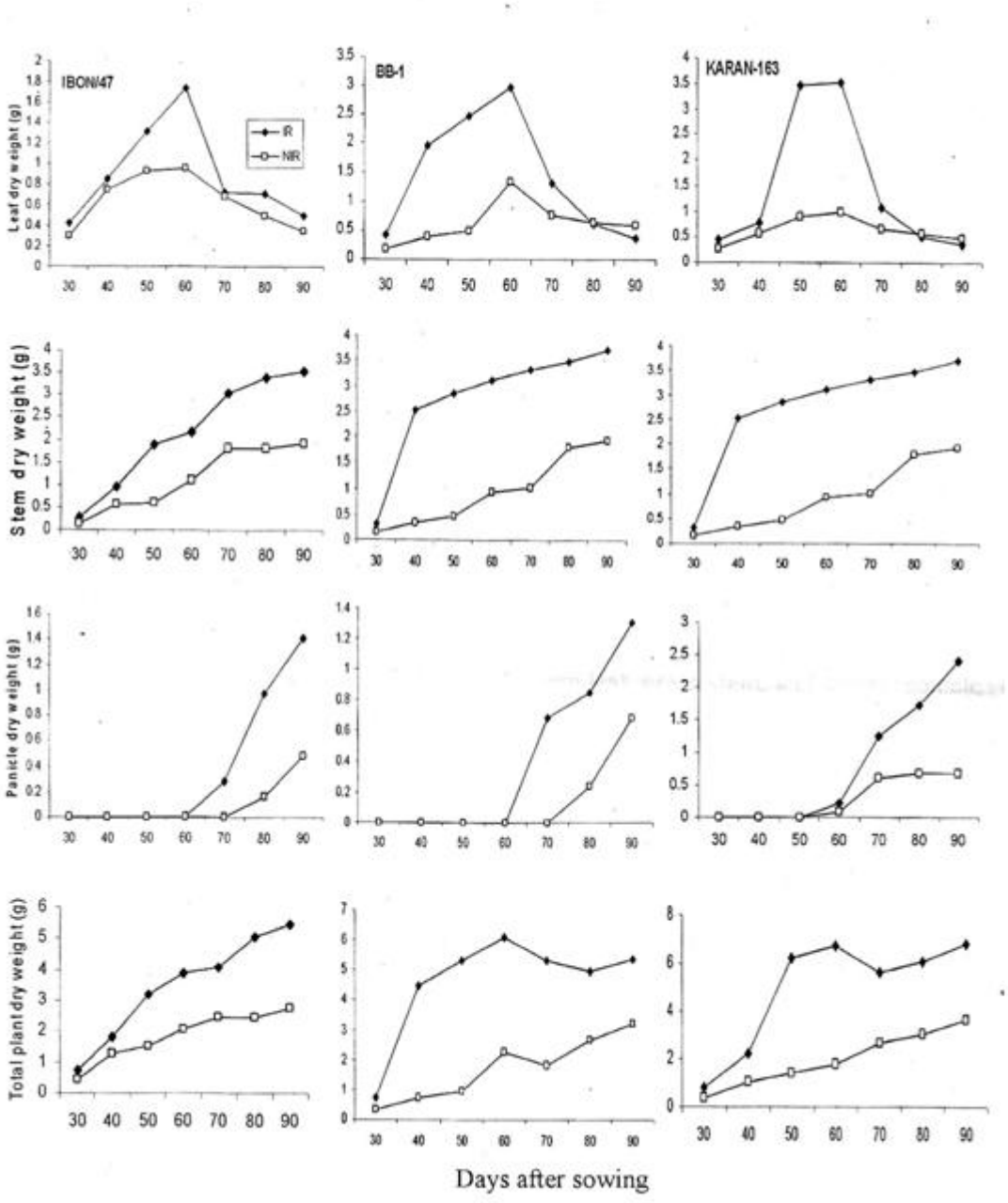
Panicle dry matter accumulation

The irrigated plants of all the cultivars had higher panicle dry weight than the rainfed plants (Fig. 3). Panicle dry weight is a major yield contributing character found to increase with irrigation treatment in the present study. KARAN -163 had the highest panicle dry weight in the irrigated condition than other cultivars.

Total dry matter accumulation/plant

Soil moisture had significant effect on production of total plant dry weight of three cultivars at most of the growth stages (Fig. 4). The irrigated plants had higher total dry weight than the rainfed plants for all the cultivars at most of the stages of growth. Similar result was reported by Krogman and Hobbs (1975) in rape; Mondal and Paul (1992) and Begum and Paul (1993) in mustard: Highest total plant dry weight was found in KARAN-163 in both conditions. Leaf dry weight and stem dry weight of the plant are related to crop productivity (Turner and Begg, 1981). The food synthesis is mainly carried out by different organs of plants like green leaf, green stem, leaf sheath, panicle and awn. Soil moisture largely influences the photosynthesis and it is expected that soil moisture in the plants effect on the rate of photosynthesis and ultimately on total dry matter which was in conformity with Johnson *et al.* (1990) and Rees (1963).

Effects of different soil moisture on the percentage distribution of dry matter in the different plant parts are shown in Figures 5, 6, 7, respectively for IBON/47, BB-1 and KARAN-163. More dry matter accumulated in the leaves of irrigated plants, especially in the early stages of growth.



Figs. 1-4. Effect of soil moisture on leaf, stem, panicle dry weight and total plant dry weights of three barley cultivars at successive stages of growth.

Proportionately panicle had the lower amount of dry matter. In the present study, more dry matter accumulation by soil moisture application could be attributed to increase in the number of leaves. Soil moisture deficits affect the growth and development of crops and towards permanent wilting point affects many physiological functions of plants and for that the plants become metabolically inactive under drought condition and the photosynthesis and production of dry matter become decreased.

Legg *et al.* (1979) reported that the main cause of loss of total dry matter yield of rainfed barley was the reduction in leaf number due to decrease leaf area and premature senescence. Loss of leaf area caused by a decrease in number of tillers and also of leaf size meant that less water used (Day *et al.* 1978).

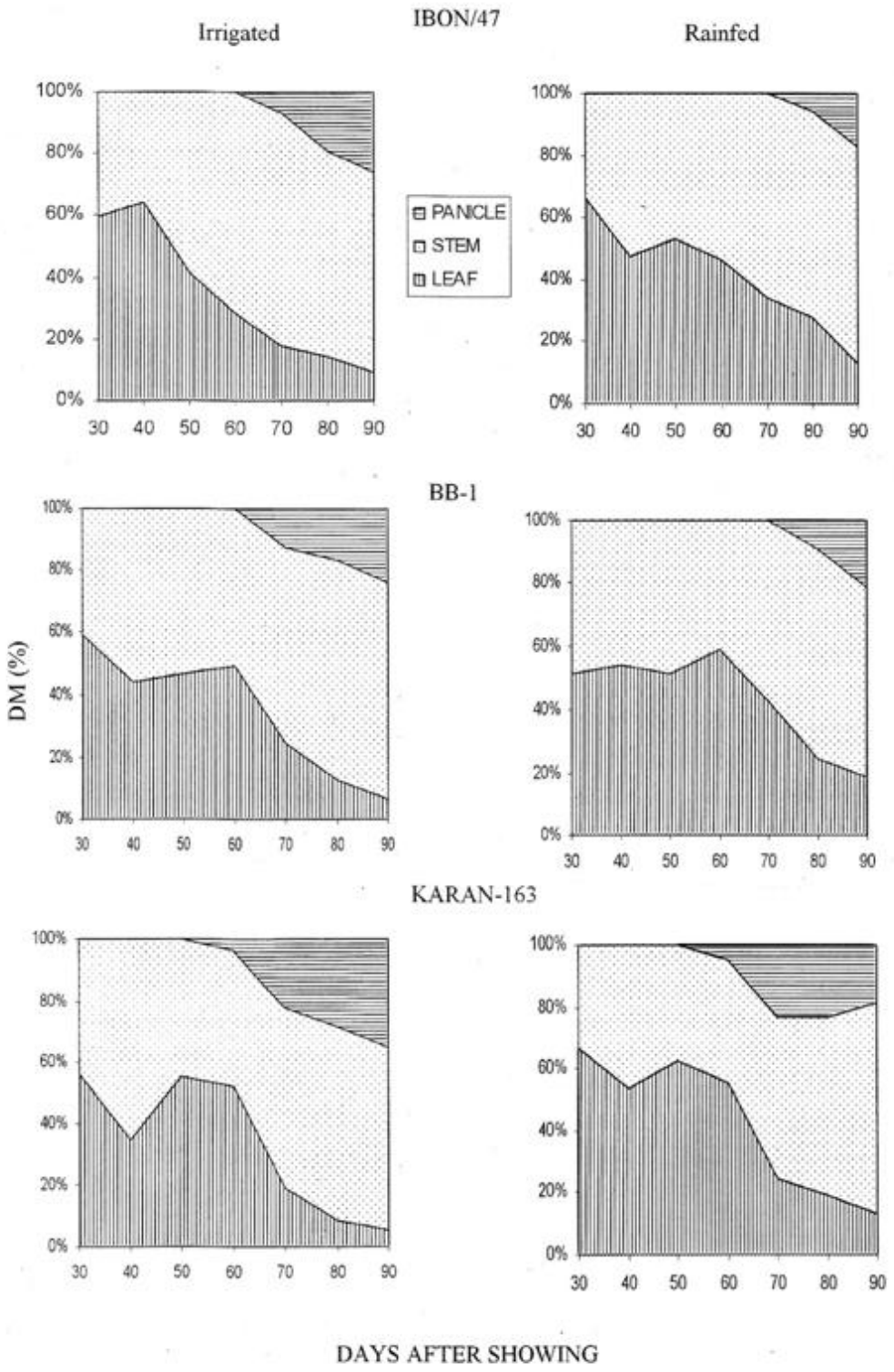


Fig. 5. Effect of soil moisture on distribution of dry matter (%) into different parts (leaf, stem, panicle) of three cultivars of successive stages of growth.

These effects are primarily attributed by the leaf Rahman *et al.* 2001 and Yadav *et al.* 2003 have pointed out that soil water stress reduces the expansion and final size of the leaf and all these can be measured by leaf area and leaf dry weight parameter. When Number of leaves or tillers will be decreased due to soil moisture treatment then automatically total dry matter must be decreased.

Percentage of stem dry matter was greater in the irrigated plants at most of the stages of growth. With the advance of plant age the distribution of dry matter increased in the stem and decreased in the leaf This effect of soil moisture has also been reported by the other workers (Kundu and Paul 1996 in rape; Srinivasan *et al.* 1987 in groundnut, Mondal and Paul 1996 in mustard; Anisuzzaman 2003 in barley).With the increase of panicle dry matter; there was a corresponding decrease of leaf dry matter in both the treatments. Panicle dry matter was greater in the irrigation treatment at all of the stages of growth. Leaves do contribute to seed formation reported by Hozyo *et al.* (1972), Freyman *et al.* (1973) and Biswas *et al.* (1990). Leaves and seeds are important in photosynthesis and yield increase from continued adequate soil moisture was due to greater combined amount of photosynthetic leaf and pod tissue (Krogman and Hobbs 1975).

References

Anisuzzaman M. 2003. Interaction between genotypes and environments shown by some quantitative characters in barley (*Hordeum vulgare* L.). Ph. D. Thesis, University of Rajshahi, Rajshahi, Bangladesh.

Asana RD. 1961. Analysis of drought resistance in wheat. Plant Water Relationships in Arid and Semi-Arid Condition. Arid Zone Research **16**, 183-190.

Begum FA, Paul NK. 1993. Influence of soil moisture on growth, water use and yield of mustard. Journal of Agronomy and Crop Science **170**, 136-141. http://dx.doi.org/10.1111/j.1439-037X.1993.tb01067.x

Biswas SC, Roy KM, Paul NK. 1990. Pattern of flower and pod production on the various inflorescences in rape and mustard. Bangladesh Journal of Botany **19**, 231-234.

D' Souza MA, Coulson CL. 1988. Dry matter production and partitioning in two cultivars of *Phaseolus vulgaris* under different watering regimes. Tropical Agriculture (Trinidad) **65,** 179-184.

Day W, Legg BJ, French BK, Johnston AE, Lawlor DW, De Jeffers CW. 1978. A drought experiment using mobile shelters: the effects of drought on barley yield, water use and nutrient uptake. Journal of Agricultural Science **91**, 599-623.

Freyman S, Charnetski WA, Crookston RK. 1973. Role of leaves in the formation of seed in rape. Canadian Journal of Plant Sciences **53**, 693-694.

Ghosh L. 2005. Relative responses of some selected high yielding varieties of barley *(Hordeum vulgare* L.) grown under different environment. Ph.D Thesis, University of Rajshahi, Rajshahi, Bangladesh.

Hozyo Y, Kato S, Kobayashi H. 1972. Photosynthetic activity of the pods of rape plants *(Brassica napus* L.) and the contribution of pods to the ripening of rape seeds (In Japanese). Japanese Journal of Crop Science **41,** 420-425.

Johnson JW, Bruckner PL, Morey DD. 1990. Relationship among flag leaf characteristics and yield of wheat. Cereal Research Communications **18**, 283-289.

Kirby EJM. 1969. The growth and development of some barley varieties in response to irrigation and nitrogen fertilizer. Journal of Agricultural Science **72**, 467-474.

Krogman KK, Hobbs EH. 1975. Yield and morphological response of rape *(Brassica campestris* L. cv. Span) to irrigation and fertilizer treatments. Canadian Journal of Plant Sciences **55**, 903-909.

Kundu PB, Paul NK. 1996. Influence of watering on production and partitioning of dry matter in three cultivars of rape *(Brassica campestris* L.).

Rajshahi University studies, Part-B, Journal of Science **23-24**, 229-235.

Legg BJ, Day W, Lawlor W, Parkinson KJ. 1979. The effects of drought on barley growth: models and measurements showing the relative importance of leaf area and photosynthetic rate. Journal of Agricultural Science, Great Britain **92**, 703-716.

Mondal RK, Paul NK. 1996. Effect of irrigation levels at different stages of growth on dry matter production and yield of mustard *(Brassica juncea* L.). Rajshahi University studies, Part-B, Journal of Science **23-24**, 221-227.

Mondal RK, Paul NK. 1992. Effect of irrigation on growth and some physiological characters of mustard *(Brassica juncea* L.). Bangladesh Journal of Agricultural Research **17**, 29-36.

Paul NK, Saha SK. 1998. Leaf growth, dry matter accumulation arid rooting pattern of wheat under moisture stress. Rajshahi University Studies Part-B **26**, 163-174.

Rahman MS, Sarker AM, Paul NK. 2001. Effect of soil moisture on phenology and accumulated heat units in wheat. Bangladesh Journal of Science and Technology **3(2)**, 273-279.

Rees AR. 1963. Relationship between crop growth rate and leaf area index in the oil palm. Nature (Lond.) **197**, 63-64.

Sivakumar MVK, Shaw RH. 1978. Methods of growth analysis in field grown soybeans, *Glycine max* L. Merill. Annals of Botany **42**, 213-222.

Sivakumar MVK, Seetarama N, Singh S, Bidinger FR. 1979. Water relations, growth and dry matter accumulation of sorghum under post-rainy season condition. Agronomy Journal **71**, 843-847.

Srinivasan PS, Sathasivum R, Arjunan A, Sethupathi R, Vaman BM. 1987. Effect of water stress on partitioning of dry matter and crop growth rate in relation to productivity in groundnut cultivars. Journal of Oilseeds Research **4,** 89-96.

Turk KJ, Hall AE, Asbell CW. 1980. Drought adaptation of cowpea. I. Influence of drought on seed yield. Agronomy Journal **72**, 413-420.

Turner NC, Begg JE. 1981. Plant water relations and adaptation to stress. Plant Science **58**, 97- 131. http://dx.doi.org/10.1007/BF02180051

Wallace DM, Munger HM. 1965. Studies on the physiological basis for yield differences. I. Growth analysis of six dry bean varieties. Crop Science **5**, 343-348.