RESEARCH ARTICLE

DRY MATTER PARTITIONING OF MAIZE PLANT AS AFFECTED BY WATER MANAGEMENT AT DIFFERENT GROWTH STAGES

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ABSTRACT

The research work was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, in the fiscal year 2017-2018 to study the dry matter partitioning of maize plant affected by water management at different growth stages. The research was conducted in a split plot design with three replications where irrigation stages were allocated in main plots and varieties were allocated in sub plots. There were five irrigation management treatments viz. I₀ - (No irrigation), I₁ - (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage), I₂ - (Four leaf stage+ eight leaf stage + tasselling stage), I₃ - (Eight leaf stage + tasselling stage +grain filling stage), I₄ - (Four leaf stage + tasselling stage+ grain filling stage), I₅ - (Four leaf stage+ eight leaf stage+ grain filling stage) and there were three varieties viz. V₁ - (BARI hybrid vutta-9), V₂ - (BARI hybrid vutta-13), V₃ - (pacific-559) in the experiment. The highest dry matter by root, culm, leaf, tassel and cob as well as by total dry matter and seed yield was obtained with the water management treatment I₁(Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) which is statistically similar to treatment I₄(Four leaf stage + tasselling stage+ grain filling stage) and the highest dry matter by root, culm, leaf, tassel and cob as well as total dry matter and seed yield was obtained due to the varietal factor V₃ (pacific-559). Interaction between I₁ irrigation treatment and V₃ varietal factor (I₁V₃) were found to be the best combination for maximum dry matter production which is statistically similar to I₄V₃ interaction. As I₄ treatment and I₄V₃ interaction are cost effective than I₁ treatment and I₁V₃ interaction, respectively, irrigation should be given at Four leaf stage, tasselling stage, and grain filling stage with variety pacific-559 for maximum dry matter as well as for maximum grain production in maize.

KEYWORDS

dry matter partitioning, maize, irrigation

1. INTRODUCTION

Maize (*Zea mays*) is one of the most important cereal crops of the world specially for the developing countries. It is third in rank after wheat and rice. Maize is annual cross-pollinated crop having erect, thick and strong culms with nodes and internodes. It is normally monoecious with staminate and pistillate flowers produce on the tassel and ear. Improvement of the productivity of cereal maize is badly needed for attaining food security in the developing countries. For improving maize productivity more emphasis should be focused on the physiology of grain production in relation to the dry matter accumulation as the grain yield production of maize is closely related to the physiology of dry matter accumulation (Tanaka and Yamaguchi, 1972).

The yield of a crop is related to its various agronomic traits such as growth, development and photo synthetically active leaf area. Different maize varieties have different trend of dry matter accumulation (Luis and Ricardo, 1997). Differences in dry matter accumulation and their distribution in different plant parts are the important determinants for selecting high yielding genotypes (Hossain and Khan, 2003). The dry matter production in cereals is highly depended on plant photosynthetic efficiency and the sink capacity to accumulate the photosynthates from the

leaf (Hao et al., 2016). The dry matter production highly influenced the plant biomass production and grain yield of the crop (Hocking et al., 1997; Plautet et al., 2004).

Drought is known to affect morphology, photo-synthesis, and dry matter (DM) accumulation as well as grain yield and the nutritional composition of maize (Çakir, 2004; Soler et al., 2007; Hao et al., 2016; Gheysari et al., 2017). It is widely recognized that maize is sensitive to drought throughout the growing season, especially during its reproductive stages (Denmead and Shaw, 1960; Grant et al., 1989; Çakir, 2004; Saseendran et al., 2014). (Denmead and Shaw, 1960) noted that drought stress during the vegetative stage of maize production reduced grain yield by 25%, drought stress during silking reduced grain yield by 50%. Following these background literatures this study was aims to find out how irrigation frequency at different growth stages of maize affect dry matter accumulation in different parts of the plants.

2. MATERIALS AND METHODS

2.1 Experimental Site

The research was conducted at the Agronomy Field Laboratory,

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Bangladesh Agricultural University, Mymensingh in the fiscal year 2017-2018. The Experimental site is located at 24°75' N latitude and 90°50' E longitude at an elevation of 18 m above the sea level. The site falls under the Old Brahmaputra Floodplain Agro- ecological Zone AEZ-9 (UNDP and FAO, 1988). The experimental field was a medium high land with silty clay loam soil texture having PH value of 7.30. The experimental site belongs to Non-calcareous Dark-gray Floodplain Soil. The physio-chemical properties of the soil have been presented in (Table 1).

Table 1: Physical and chemical properties of soil	
Physical characteristics of the soil	Chemical characteristics of the soil
1. Sand (%) (0.2-0.02 min) :10	1. pH : 7.30
2. Silt (%) (0.02-0.002 min) : 60	2. Organic matter (%) : 1.11
3. Clay (%) (<0.002 min) : 30	3. Total nitrogen (%) : 0.16
4. Soil textural class : silty clay loam	4. Available sulphur (ppm) : 14.2
5. Particle density (g/cc): 2.60	5. Available phosphorus (ppm) : 13.44
6. Bulk density (g/cc) : 1.35	6. Exchangeable potassium : 48.43
7. Porosity (%) : 46.67	

Source: Results obtained from the mechanical analysis of the initial soil sample done in the Department of Soil Science, Bangladesh Agricultural University, Mymensingh.

2.2 Climate

The experimental site is located under subtropical climate having high temperature, high humidity and heavy rainfall with occasional strong winds during April-September and limited rainfall associated with moderately low temperature with huge sunshine during October to March. Weather information regarding rainfall, temperature, relative humidity, sunshine hours at the experimental site during the period of study have been presented in (Table 2).

Table 2: Monthly air temperature, rainfall, relative humidity and sunshine hours during the growing period						
Month	Air temperature (°C)			Rainfall (mm)	Relative humidity (%)	Sunshine (hrs.)
	Maximum	Minimum	Average			
January 2018	23.90	13.50	18.9	15.2.0	82.8	132.5
February 2018	26.80	15.60	21.2	19.6	79.5	122.2
March 2018	30.6	18.4	24.6	0.7	74.5	217.1
April 2018	30.60	21.4	26.0	206.5	81.0	139.6
December 2017	24	22.14	21	17.01	80	130
November 2017	26	20.1	24	18	78.01	130

Source: Weather Yard, Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh

2.3 Planting material

For conducting the experiment three cultivars of maize crops have been selected namely BARI Hybrid vutta-9, BARI Hybrid vutta-13 and a Thai origin maize cultivar Pacific-559. BARI Hybrid vutta-9 and BARI Hybrid vutta-13 have been collected from Bangladesh agricultural research Institute and Pacific-559 has been collected from local seed marketer.

2.4 Experimental Treatment

The experiment was conducted considering the following factor treatments:

Factor A: Water Management	Factor B: Variety
I ₀ = No irrigation	V ₁ = BARI hybrid vutta-9
I ₁ = Irrigation at (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage)	V ₂ = BARI hybrid vutta-13
I ₂ = Irrigation at (Four leaf stage+ eight leaf stage + tasselling stage)	V ₃ = Pacific-559
I ₃ = Irrigation at (Eight leaf stage + tasselling stage + grain filling stage)	
I ₄ = Irrigation at (Four leaf stage + tasselling stage+ grain filling stage)	
I ₅ = Irrigation at (Four leaf stage+ eight leaf stage+ grain filling stage)	

2.5 Experimental design and layout

The experiment was designed in a split plot with three replications. In this experiment above mentioned water management treatments were placed in main plots and varietal factors were distributed in sub plots. Then total number of plots was (6×3×3) = 54 and a single plot size was (4m×2.5m) = 10m².

2.6 Crop husbandry

The site was ploughed with tractor operated mould board plough and repeated harrowing was done in order to bring the soil in fine tilth condition. The experimental land was fertilized with 500-250-180-240-10 kg/ha urea, triple super phosphate, muriate of potash, gypsum and zincsulphate, respectively. All the fertilizers were applied at the time of final land preparation except urea and rest of the urea was top-dressed in two equal portion at 30 and 50 DAS. Seeds of selected maize cultivars were used for sowing with recommended seed rate of 20 kg/ha. Irrigation was applied as per the proposed water management treatments. Then crop was harvested in April, 2018 at harvest maturity.

2.7 Collection of experimental data and statistical analysis

Ten plants were uprooted from the soil for determination of dry matter production and it's partitioning in different parts of the plant. The harvested ten plants were separated into leaves, stem, tassel, cob and root parts. These plant parts were dried at 65°C to 70°C to constant dry weight. Dry weight was recorded separately at harvest to calculate dry matter accumulation in different parts and total dry matter production and it was expressed in g/plant. Collected data were tabulated to perform analysis of variance and the mean difference was adjudged by Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez (1984) with the help of computer package program (M-STATC).

3. RESULTS

3.1 Dry matter production at different parts of plant at harvest

3.1.1 Effect on Leaf dry weight (gplant⁻¹)

Leaf dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 3) due to different water management treatments. Leaf dry weight (gplant⁻¹) at harvest for different water management treatments ranged from 17.03 to 30.04 g (Table 3). The highest leaf dry weight (30.04 gplant⁻¹) was observed with the water management treatment I₁ (I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) which is statistically similar to I₄ (I₄ = Four leaf stage + eight leaf stage + grain filling stage) treatment and the lowest leaf dry weight (17.03gplant⁻¹) was observed in I₀ (No irrigation) treatment (Table 3). Leaf dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability due to different variety (Table 4). The leaf dry weight (gplant⁻¹) at harvest for different varieties ranged from 17.86 to 30.31 g (Table 4).

The highest leaf dry weight (30.31gplant⁻¹) was observed with the varietal factor V₃ (pacific-559) and the lowest leaf dry weight (17.86 gplant⁻¹) was observed in the factor V₂ (BARI hybrid vutta-13) (Table 4). The leaf dry

weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 5) due to Interaction effects of different water management treatment and variety. The leaf dry weight (gplant⁻¹) at harvest for interaction effect ranged from 14.50 to 36.00 g (Table 5). The highest leaf dry weight (36.00 gplant⁻¹) was observed with the interaction effect of I₁V₃ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with pacific-559) which is statistically similar to I₄V₃ (Four leaf stage + eight leaf stage + grain filling stage with Pacific-559) interaction and the lowest leaf dry weight (14.50 gplant⁻¹) was observed in I₀V₂ (No irrigation with BARI hybrid vutta-13) interaction (Table 5).

3.1.2 Effect on culm dry weight (gplant⁻¹)

Culm dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 3) due to different water management treatments. Culm dry weight (gplant⁻¹) at harvest for different water management treatments ranged from 12.13 to 35.37 g (Table 3). The highest culm dry weight (32.37 gplant⁻¹) was observed with the water management treatment I₁ (I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) which is statistically similar to I₄ (I₄ = Four leaf stage + eight leaf stage + grain filling stage) treatment and the lowest culm dry weight (12.13 gplant⁻¹) was observed in I₀ (No irrigation) treatment (Table 3). Culm dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability due to different variety (Table 4). The culm dry weight (gplant⁻¹) at harvest for different varieties ranged from 16.23 to 34.63 g (Table 4).

The highest culm dry weight (34.63 gplant⁻¹) was observed with the varietal factor V₃ (pacific-559) and the lowest culm dry weight (16.23 gplant⁻¹) was observed in the factor V₂ (BARI hybrid vutta-13) (Table 4). The culm dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 5) due to Interaction effects of different water management treatment and variety. The culm dry weight (gplant⁻¹) at harvest for interaction effect ranged from 9.70 to 40.20 g (Table 5). The highest culm dry weight (40.20 gplant⁻¹) was observed with the interaction effect of I₁V₃ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with pacific-559) which is statistically similar to I₄V₃ (Four leaf stage + eight leaf stage + grain filling stage with Pacific-559) interaction and the lowest culm dry weight (9.70 gplant⁻¹) was observed in I₀V₂ (No irrigation with BARI hybrid vutta-13) interaction (Table 5).

3.1.3 Effect on root dry weight (gplant⁻¹)

Root dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 3) due to different water management treatments. Root dry weight (gplant⁻¹) at harvest for different water management treatments ranged from 10.22 to 18.19 g (Table 3). The highest root dry weight (18.19 gplant⁻¹) was observed with the water management treatment I₁ (I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) followed by I₄ (I₄ = Four leaf stage + eight leaf stage + grain filling stage) treatment and the lowest root dry weight (10.22 gplant⁻¹) was observed in I₀ (No irrigation) treatment (Table 3). Root dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability due to different variety (Table 4). The root dry weight (gplant⁻¹) at harvest for different varieties ranged from 9.90 to 19.30 g (Table 4).

The highest root dry weight (19.30 gplant⁻¹) was observed with the varietal factor V₃ (pacific-559) and the lowest root dry weight (9.90 gplant⁻¹) was observed in the factor V₂ (BARI hybrid vutta-13) (Table 4). The root dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 5) due to Interaction effects of different water management treatment and variety. The root dry weight (gplant⁻¹) at harvest for interaction effect ranged from 7.85 to 28.49 g (Table 5). The highest root dry weight (28.49 gplant⁻¹) was observed with the interaction effect of I₁V₃ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with pacific-559) followed by I₄V₃ (Four leaf stage + eight leaf stage + grain filling stage with Pacific-559) interaction and the lowest root dry weight (7.85 gplant⁻¹) was observed in I₀V₂ (No irrigation with BARI hybrid vutta-13) interaction (Table 5).

3.1.4 Effect on tassel dry weight (gplant⁻¹)

Tassel dry weight (gplant⁻¹) at harvest was statistically significant at 5% level of probability (Table 3) due to different water management treatments. Tassel dry weight (gplant⁻¹) at harvest for different water management treatments ranged from 3.90 to 6.51 g (Table 3). The highest tassel dry weight (6.51gplant⁻¹) was observed with the water management treatment I₁ (I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) which is statistically similar to I₄ (I₄ = Four leaf stage + eight leaf stage + grain filling stage) treatment and the lowest tassel dry weight (3.90 gplant⁻¹) was observed in I₀ (No irrigation) treatment (Table 3). Tassel dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability due to different variety (Table 4). The tassel dry weight (gplant⁻¹) at harvest for different varieties ranged from 4.46 to 6.33 g (Table 4). The highest tassel dry weight (4.46 gplant⁻¹) was observed with the varietal factor V₃ (pacific-559) and the lowest tassel dry weight (6.33 gplant⁻¹) was observed in the factor V₂ (BARI hybrid vutta-13) (Table 4). The tassel dry weight (gplant⁻¹) at harvest was statistically non-significant (Table 5).

3.1.5 Effect on cob dry weight (gplant⁻¹)

Cob dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 3) due to different water management treatments. Cob dry weight (gplant⁻¹) at harvest for different water management treatments ranged from 85.24 to 137.21 g (Table 3). The highest cob dry weight (137.21 gplant⁻¹) was observed with the water management treatment I₁ (I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) followed by I₄ (I₄ = Four leaf stage + eight leaf stage + grain filling stage) treatment and the lowest cob dry weight (85.24gplant⁻¹) was observed in I₀ (No irrigation) treatment (Table 3). Cob dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability due to different variety (Table 4). The cob dry weight (gplant⁻¹) at harvest for different varieties ranged from 79.24 to 131.39 g (Table 4).

The highest cob dry weight (131.39gplant⁻¹) was observed with the varietal factor V₃ (pacific-559) and the lowest cob dry weight (79.24 gplant⁻¹) was observed in the factor V₂ (BARI hybrid vutta-13) (Table 4). The cob dry weight (gplant⁻¹) at harvest was statistically significant at 1% level of probability (Table 5) due to Interaction effects of different water management treatment and variety. The cob dry weight (gplant⁻¹) at harvest for interaction effect ranged from 80 to 132.39 g (Table 5). The highest cob dry weight (132.3 g) was observed with the interaction effect of I₁V₃ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with pacific-559) which is statistically similar to I₄V₃ (Four leaf stage + eight leaf stage + grain filling stage with Pacific-559) interaction and the lowest cob dry weight (80gplant⁻¹) was observed in I₀V₂ (No irrigation with BARI hybrid vutta-13) interaction (Table 5).

Table 3: Effect of water managements on dry matter partitioning of maize at harvest

Dry matter (gplant ⁻¹) production at harvest					
Treatments	Root	Culm	Leaves	Tassel	Cob
I ₀	10.22 f	12.13 e	17.03 e	3.90 e	85.24e
I ₁	18.19 a	35.37 a	30.04 a	6.51 a	137.21 a
I ₂	11.81 d	19.18 c	21.10 c	5.15 c	119.47 c
I ₃	13.32 c	25.14 b	25.89 b	5.37 b	126.27 b
I ₄	17.24 b	35.33 a	29.09 a	6.45 a	134.54 a
I ₅	11.05 e	14.72 d	19.30 d	4.51 d	110 d
Level of sig.	**	**	**	*	**
CV(%)	6.02	9.67	4.8	2.2	6.27

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

** =Significant at 1% level of probability, * =Significant at 5% level of probability, I₀ = No irrigation, I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage, I₂ = Four leaf stage + eight leaf stage + tasselling stage, I₃ = Eight leaf stage + tasselling stage +grain filling stage, I₄ = Four leaf stage + tasselling stage+grain filling stage, I₅ = Four leaf stage + eight leaf stage + grain filling stage

Table 4: Effect of Varieties on dry matter partitioning of maize at harvest

Dry matter (gplant ⁻¹) production at harvest					
Varyties	Root	Culm	Leaves	Tassel	Cob
V ₁	11.70 b	21.57 b	23.58 b	5.37 b	79.24 b
V ₂	9.90 c	16.23 c	17.86 c	4.46 c	109
V ₃	19.30 a	34.63 a	30.31 a	6.33 a	131.39 a
Level of sig.	**	**	**	**	**
CV(%)	3.92	8.19	4.81	1.1	6.33

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).

** =Significant at 1% level of probability, V₁ = BARI hybrid vutta-9, V₂ = BARI hybrid vutta-13, V₃ = Pacific-55.

Table 5: Interaction effect of water managements and varieties on dry matter partitioning of maize at harvest

Dry matter (gplant ⁻¹) production at harvest					
Interactions	Root	Culm	Leaves	Tassel	Cob
I ₀ xV ₁	9.89 j	11.70 hi	15.50 h	4.60 hi	85 hi
I ₀ xV ₂	7.85 k	9.70 i	14.50 h	4.46 i	80 i
I ₀ xV ₃	12.91 fg	15.02 fg	21.20 e	5.50 fg	109.54 fg
I ₁ xV ₁	13.16 f	33.70 b	32.65 b	6.20 b	121 b
I ₁ xV ₂	12.89 fg	23.20 a	21.46 e	6.00 d	119 d
I ₁ xV ₃	28.49 a	40.20 a	36.00 a	7.00 a	132.39 a
I ₂ xV ₁	11.06 i	14.27 gh	19.20 fg	4.95 gh	99.21 gh
I ₂ xV ₂	9.24 j	12.90 gh	17.74 g	4.87 gh	95 gh
I ₂ xV ₃	15.13 d	30.39 c	29.40 c	6.15 c	120.21 c
I ₃ xV ₁	12.26 gh	23.19 d	24.68 d	6.00 d	119 d
I ₃ xV ₂	9.70 j	17.01 ef	18.01 g	5.76 ef	113.54 ef
I ₃ xV ₃	18.00 c	35.21 b	35.00 a	6.28 b	126.50 b
I ₄ xV ₁	13.00 fg	33.01 b	31.17 b	6.21 b	123.21 b
I ₄ xV ₂	11.62 hi	22.02 d	20.83 ef	5.95 d	117 d
I ₄ xV ₃	27.17 b	39.97 a	35.33 a	6.78 a	131.41 a
I ₅ xV ₁	11.00 i	13.54 gh	18.31 g	4.90 gh	98.54 gh
I ₅ xV ₂	8.00 k	12.63 gh	14.60 h	4.85 gh	96 gh
I ₅ xV ₃	14.20 e	18.00 c	25.00 d	5.80 e	116.21 e
Level of sig.	**	**	**	NS	**
CV(%)	3.9	8.19	4.84	5.51	6.33

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), ** =Significant at 1% level of probability, NS= Non significant, I₀ = No irrigation, I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage, I₂ = Four leaf stage + eight leaf stage + tasselling stage, I₃ = Eight leaf stage + tasselling stage +grain filling stage, I₄ = Four leaf stage + tasselling stage+grain filling stage, I₅ = Four leaf stage + eight leaf stage + grain filling stage, V₁ = BARI hybrid vutta-9, V₂ = BARI hybrid vutta-13, V₃ = Pacific-55.

3.1.6 Effect on total dry weight (gplant⁻¹)

The highest total dry weight (227.32 gplant⁻¹) was observed with the water management treatment I₁ (I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) which is statistically similar to I₄(Four leaf stage +tasselling stage+ grain filling stage)treatment and the lowest total dry weight (128.52 gplant⁻¹) was observed in I₀ (No irrigation) treatment (Figure 1). The highest total dry weight (221.96gplant⁻¹) was observed with the varietal factor V₃ (pacific-559) and the lowest total dry weight (141.46gplant⁻¹) was observed in the factor V₁ (BARI hybrid vutta-9) (Figure 2). The highest total dry weight (240.66 gplant⁻¹) was observed with the interaction effect of I₄V₃ (Four leaf stage +tasselling stage+ grain filling stage with pacific-559) and the lowest total dry weight (116.51 gplant⁻¹) was observed in I₀V₂ (No irrigation with BARI hybrid vutta-13) interaction (Figure 3).

Figure 1: Effect of water management treatment on total dry matter production

I₀ = No irrigation, I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage, I₂ = Four leaf stage + eight leaf stage + tasselling stage, I₃ = Eight leaf stage + tasselling stage +grain filling stage, I₄ = Four leaf stage + tasselling stage+grain filling stage, I₅ = Four leaf stage + eight leaf stage + grain filling stage

Figure 2: Effect of varieties on total dry matter production

V₁ = BARI hybrid vutta-9, V₂ = BARI hybrid vutta-13, V₃ = Pacific-55

Figure 3: Interaction effect (Water management X Varieties) on total dry matter production

(I₀ = No irrigation, I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage, I₂ = Four leaf stage + eight leaf stage + tasselling stage, I₃ = Eight leaf stage + tasselling stage + grain filling stage, I₄ = Four leaf stage + tasselling stage+grain filling stage, I₅ = Four leaf stage + eight leaf stage + grain filling stage, V₁ = BARI hybrid vutta-9, V₂ = BARI hybrid vutta-13, V₃ = Pacific-55.

3.2 Effect on seed yield

The highest seed yield (5880 kg/ha) was found from I₁ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) which is statistically similar to I₄ (Four leaf stage + tasselling stage+grain filling stage) irrigation treatment and the lowest seed yield (5400 kg/ha) was found from I₀ (No irrigation) water management treatment (Figure 4). The highest seed yield (5870 kg/ha) was recorded from V₃ (pacific-559) and the lowest seed yield (5550 kg/ha) was recorded from V₂ (BARI hybrid vutta-13) (Figure 5). Incase of interaction effect the highest seed yield (6000 kg/ha) was found from I₁V₃ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with Pacific-559) interaction effect which is statistically identical to I₄V₃ (Four leaf stage + eight leaf stage + grain filling stage with Pacific-559) and the lowest seed yield (5050 kg/ha) was found from I₀V₃ (No irrigation with pacific-559) interaction effect (Figure 6).

Figure 4: Effect of water management on seed yield of maize

I₀ = No irrigation, I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage, I₂ = Four leaf stage + eight leaf stage + tasselling stage, I₃ = Eight leaf stage + tasselling stage + grain filling stage, I₄ = Four leaf stage + tasselling stage+grain filling stage, I₅ = Four leaf stage + eight leaf stage + grain filling stage

Figure 5: Effect of varieties on seed yield of maize

V₁ = BARI hybrid vutta-9, V₂ = BARI hybrid vutta-13, V₃ = Pacific-55

Figure 6: Interaction effect (water management X varieties) on seed yield of maize

(I₀ = No irrigation, I₁ = Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage, I₂ = Four leaf stage + eight leaf stage + tasselling stage, I₃ = Eight leaf stage + tasselling stage + grain filling stage, I₄ = Four leaf stage + tasselling stage+grain filling stage, I₅ = Four leaf stage + eight leaf stage + grain filling stage, V₁ = BARI hybrid vutta-9, V₂ = BARI hybrid vutta-13, V₃ = Pacific-55.

3.3 Correlation-co-efficient and regression equation

Total dry weight (r = 0.859), culm dry weight (r = 0.8), leaves dry weight (r = 0.826), tassel dry weight (r = 0.732) and cob dry weight (r = 0.893) showed very strong positive correlation with seed yield of maize and root dry weight (r = 0.692) showed strong positive correlation with seed yield (Table 06).

Table 6: Correlation-co-efficient and regression equation for dry matter partitioning and seed yield of maize

Parameters	Correlation-co-efficient		Regression equation
	R ² value	R value	
Total dry weight Vs Seed yield	0.738	0.859	y = 5.579x + 4719
Root dry weight Vs Seed yield	0.48	0.692	y = 27.15x + 5324
Culm dry weight Vs Seed yield	0.656	0.809	y = 17.69x + 5296
Leaves dry weight Vs Seed yield	0.683	0.826	y = 24.80x + 5101
Tassel dry weight Vs Seed yield	0.732	0.855	y = 256.7x + 4236
Cob dry weight Vs Seed yield	0.798	0.893	y = 13.00x + 4247

4. DISCUSSIONS

The highest total dry weight was observed when irrigation was applied according to I₁ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage) which is statistically similar to I₄ (Four leaf stage + tasselling stage+ grain filling stage) treatment and the lowest total dry weight was observed in I₀ (No irrigation) treatment. It is may be due to as water is an important component of photosynthesis and enough moisture was available in the critical growth stages of maize in I₁ and I₄ treatment. Similar trend also found in (Oskar et al., 2007). They reported that irrigation increased plant dry matter yield (259 to 350 g) and grain production (110 to 158 g) per plant. They also recorded that irrigation increases dry matter yield by approximately 35% without affecting the stover morphological composition and the grain to stover ratio. The highest total dry weight was observed with the cultivar pacific-559 and the lowest total dry weight was observed in the cultivar BARI hybrid vutta-9.

It was happened as different maize cultivars have different capability to produce different amount of biomass that is reported by (Luis and Ricardo, 1997). The highest seed yield was found from I₁V₃ (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with Pacific-559) interaction effect which is statistically identical to I₄V₃ (Four leaf stage + eight leaf stage + grain filling stage with Pacific-559) and the lowest seed yield was found from I₀V₃ (No irrigation with pacific-559) interaction

effect. It may be as moisture availability in critical growth stages of plant helps to attain maximum photosynthesis. Similar result also found by (Kobir et al., 2019). Ultimately with the combination of these factors the highest total dry weight as well as the highest seed yield was observed with the interaction effect of I_1V_3 (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with Pacific-559) and the lowest total dry weight was observed in I_0V_2 (No irrigation with BARI hybrid vutta-13) interaction.

As I_1V_3 (Four leaf stage + eight leaf stage + tasselling stage+ grain filling stage with Pacific-559) interaction is statistically identical to I_4V_3 (Four leaf stage +tasselling stage+ grain filling stage with pacific-559) interaction effect and as I_4V_3 (Four leaf stage +tasselling stage+ grain filling stage with pacific-559) require one time less irrigation supply then I_4V_3 (Four leaf stage +tasselling stage+ grain filling stage with pacific-559) interaction's effect is cost effective than I_1V_3 (Four leaf stage + eight leaf stage + tassellingstage+ grain filling stage with Pacific-559) interaction. From the above results it is cleared that dry matter production and it's partitioning is highly depends on irrigation frequencies and different genotypes. For all the parameters maximum result was found when irrigation was applied in four leaf stage, tasselling stage, and grain filling stage. Similar trend was also found by (Kuscu and Demir, 2012). They examined that limited irrigation applied at different growth phases of maize had different effects on the dry matter production. Their research showed that highest dry matter was found when irrigation was applied in vegetative, flowering and grain filling stage. Similar result was also found by (Mazid et al., 2017). They revealed that three times irrigation in maize results maximum straw yield.

5. CONCLUSION

The results of this research work concluded that irrigation at different specific growth stages is an important tool to make maximum dry matter production in maize and dry matter has very strong correlation with seed yield of maize. Varieties differences also influence on dry matter accumulation so far. Based on the present investigation it is revealed that irrigation should be given at four leaf stage, tasselling stage, and grain filling stage with variety pacific-559 for maximum dry matter production as well as for maximum seed yield of in maize.

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