# EFFECTS OF FREQUENCY OF IRRIGATION ON ONION (*Allium cepa* L.) BULB PRODUCTION

**A**

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**BY**

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**DEDICATED TO**

**MY BELOVED PARENTS**

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The Author

## ABSTRACT

A field experiment was conducted at the Bangladesh Agricultural University Horticulture Farm, Mymensingh during November 1989 to April 1990 to determine the optimum moisture level and optimum frequency of irrigation for bulb production of onion cv. Faridpur Bhati. There were five irrigation treatments viz. no irrigation, irrigation at 15, 30, 45 and 60% depletion of available soil moisture. The treatments were replicated three times in randomized block design.

Irrigation significantly influenced the plant growth and yield of onion. Maximum number of leaves per plant (11.58) was produced in 15% depletion regime. Irrigation at 30% depletion produced maximum plant height (43.03 cm) which was closely followed at 15% depletion (41.83 cm). Occurance of split bulb and bolting plant were higher under irrigated condition. The size of the bulb increased with irrigation. Highest yield of bulb (12.96 t/ha) was obtained in 15% depletion regime with a total water use of 195.2 mm.

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# CHAPTER I

# INTRODUCTION

The onion (*Allium cepa* L.) is one of the most important crops among the vegetables and spices. It originated in an area which includes Iran, Pakistan and the mountain region of the north of these countries (Purseglove, 1972). It grows in both tropical and temperate regions. The leading onion producing countries of the world are China, India, USSR, USA, Japan, Turkey, Spain, Brazil and Egypt (FAO, 1983).

In Bangladesh onion is grown as a winter crop. About 33.7 thousand hectares of land are under cultivation of onion in Bangladesh, with an average yield of 4 t/ha (BBS, 1987). The yield per hectare of onion is low in Bangladesh while it is much higher in many Asian and European countries, such as 8.54 t/ha in India, 41.43 t/ha in Japan and 38.54 t/ha in UK (FAO,1988).

There are a number of indigenous cultivars of onion which are widely grown in Bangladesh although they are poor yielders than those grown in many temperate countries. The indigenous cultivars store fairly well under ordinary room condition (Rabbani *et al.*, 1986) which made these cultivars popular among the growers in this country.

Production of onion bulbs depends on many factors. Irrigation is one of those factors which is very important for assured crop production. Irrigation helps increasing yield through better utilization of all other resources. In Bangladesh, onion is grown during winter season when the weather is usually dry. Supplemental irrigation is required in order to achieve higher yield. One of the reasons for poor average yield of onion in Bangladesh is, production of the crop without irrigation in most cases.

Very little information is available regarding the irrigation requirement of onion under Bangladesh conditions. Extensive research have been done on the water requirement of onion in many temperate countries. Such studies are of little importance in Bangladesh, since there is a wide variation in the agroclimatic situation of the two places. The varieties grown in Bangladesh are also different in nature. These are commonly known as tropical onion, whose response to water are likely to differ from that of temperate onion.

The present investigation was therefore undertaken with the following objectives:

1. To find out optimum moisture level for onion cultivation
2. To determine optimum frequency of irrigation

# CHAPTER II

# REVIEW OF LITERATURE

Irrigation is an important factor for successful cultivation of onion. The crop water requirement is greatly influenced by soil and climatic factors and there are many conflicting reports regarding the extent of irrigation requirement for different crops including onion. Some of the literatures related to the present experiment are presented in this chapter.

Karim *et al.* (1981) in an irrigation experiment on onion at Joydebpur, Gazipur obtained highest yield of bulb (12.6 t/ha) from 6 irrigations, with a total amount of 17.92 cm water. The yield contributing parameters were largely influenced by irrigation frequency.

Considerable work has been done in India in respect of irrigation in onion. Dastane *et al.* (1969) reported that the most critical stages for water requirement are during bulb formation and enlargement. Narang and Dastane (1969) showed that the optimum soil moisture requirement for onion was found to be 0.65 bar tension at 8 cm soil depth.

Prashar (1976) in India reported that the difference in bulb yield under different irrigation treatments was due to difference in bulb weight and harvest index. Both these parameters decreased significantly with irrigation at low soil water potential.

Achar *et al.* (1984) in an irrigation experiment with onion cv. Bellary Red observed that a regime of 50% available soil moisture and NPK @ 80:25:80 kg/ha as basal dressing gave the highest yield. Lower or higher moisture levels and lower NK levels reduced the yield of onion.

Palled *et al.* (1988) conducted a field experiment with onion cv. Bellary Red during 1984 and 1985. Based on an irrigation water and cumulative pan evaporation (IW:CPE) ratio of 0.7, irrigation with 60 mm of water gave bulb yield increases of 8.0, 24.2 and 164.5% compared with irrigation based on IW:CPE ratio of 0.9, 0.5 and no irrigation treatments, respectively. The consumptive use of water increased with increasing irrigation frequency but the maximum water use efficiency (38.3 kg/ha/mm) was recorded with a IW:CPE ratio of 0.7 over two years.

Hedge (1986) in a two year study, investigated eight different irrigation treatments on onion bulb production. Irrigation at soil water potential of 0.45-0.65 bar resulted in maximum dry matter production, nutrient uptake and yield.

El-Kalla and El-Kassaby (1985) in a two years study in Egypt, irrigated onion cv. Bechairy 1-5 times with N @ 192 kg/ha applied in different ways. The highest yield of marketable bulbs (31.32 t/ha) was obtained with 4 irrigation + N @ 96 kg/ha applied with the 2nd irrigation (35-40 days after transplanting) and another split of N @ 96 kg/ha applied one month later.

Chaudhry and Erinne (1984) in Nigeria, reported that irrigation every 3 days produced the highest yield of onion bulb (21.89 t/ha). The lowest yield (7.02 t/ha) was recorded with irrigation every 6 days. Irrigation at an interval of 3 or 6 days increased bolting and decreased storage life, whereas 4 or 5 days irrigation intervals generally kept bolting below 20% and storage losses were least. Peak soil water use was 7 weeks after planting.

Galbiatti and Castellane (1990) in a field trial in Brazil irrigated onion cv. Piratopes at 25, 50, 100 or 125% of daily evapotranspiration (average of 5mm). Mean bulb yields were recorded 14.1, 14.2, 25.0 and 30.9 t/ha, respectively indicating a higher yield when irrigated at higher percentage of evapotranspiration.

Bottcher *et al.* (1979) in a 3 year study in Germany, obtained increased marketable yield by the application of irrigation water from 20 to 66.5 mm. Even in a wet year, supplementary irrigation resulted in an extra yield.

Barnoczki (1981/82) carried out an experiment in Hungary for 2 years with 6 onion varieties raised from seed and grown with or without irrigation (6-8 times/season). Irrigation increased the yield, mean bulb weight, dry matter content, refractive values and reduced the number of under-size bulbs. It had no significent effect on flavour, number of bulbs/plot, percentage of immature bulbs, sprouting in storage condition and disease incidence.

Battilani and Lanzoni (1987) carried out an experiment on onion irrigation in Italy. Different fixed volume and varying intervals of irrigation were compared to find out the most suitable cultivar coefficient for an onion crop using an evapotranspiration pan. Determination of water volumes was related to the quantity of water needed to reinstate a hypothetical thickness of soil explored by roots and field capacity. The intervals resulted from the daily evapotranspiration and thus from the time needed to consume the water available in the thickness considered. Onion responded strongly to irrigation with maximum evapotranspiration restitutions greater than 100% and short watering intervals.

# CHAPTER III

# MATERIALS AND METHOD

The experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from November 1989 to April 1990.

## Climate and Soil Condition

Climate : The experimental site is situated in the subtropical climatic zone characterized by heavy rainfall during the months from April to October and scanty rainfall during the rest of the year. Detail weather data of this locality during the growing period is presented in Appendix 1.

Soil : The soil of the experimental site was sandy loam belonging to Brahmaputra alluvial tract. Some properties of the experimental soil are presented in Table 1.

## Variety

Onion cv. Faridpur Bhati were used in the experiment.

**Sowing of Seed**

Germinated onion seeds were broadcasted in the prepared bed by hand on 11 November 1989. Proper manuring, fertilizing, thinning, watering and weeding were practiced to get healthy seedlings.

TABLE 1 . Some properties of experimental soil.

| Sl.No. | Soil parameters | Inference | Methods/apparatus used |
|---|---|---|---|
| 1. | Soil Texture | Sand = 60%<br>Silt = 32%<br>Clay = 8% | Hydrometer method |
| 2. | Bulk density ($g/cm^3$) | 1.60 | Core sampling method |
| 3. | Particle density ($g/cm^3$) | 2.60 | Volumetric flask method |
| 4. | Porosity (%) | 38.46 | Relation between bulk density & particle density |
| 5. | Field capacity (% moisture) | 26.80 | Field method |
| 6. | Wilting point (% moisture) | 18.0* | Literature review |
| 7. | Soil pH | 6.30 | pH metre |

* Soil parameters were estimated in 0-12 cm depth.

**Land preparation**

The land was prepared by deep ploughing with a tractor followed by harrowing and laddering. The weeds and stubbles were removed. Basal doses of manures and fertilizers were applied during final land preparation. Furadan @ 15 kg/ha was incorporated into the soil during land preparation to prevent the cut worms. Finally experimental plots were prepared, keeping 1.0 m spacing in between two plots.

**Transplanting of seedlings**

Healthy seedlings were uprooted from the seed bed. After slight trimming of leaves and roots, seedlings were transplanted in the experimental plots. Plant to plant spacing was 10 cm and row to row spacing was 20 cm. Transplanting was done on 11 January 1990.

**Manures and fertilizers**

The crop was fertilized with well-decomposed cowdung, urea, triple superphosphate and muriate of potash at the following rate:

Cowdung 15 tons/ha

Urea 225 kg/ha

Triple superphosphate 125 kg/ha

Muriate of potash 150 kg/ha.

Cowdung was incorporated during the general land preparation. Total doses of triple superphosphate and 1/3 rd of urea and muriate of potash were applied to the soil 7 days before transplanting. Rest of the urea and muriate of potash was top dressed in equal instalments after 3rd and 7th weeks of transplanting of seedlings in the experimental plots.

**Design of the experiment and treatments**

The experiment was laid out in the randomized block design with three replications. The dimension of the unit plots was 2.0 m X 1.5 m. Each plot was raised by 10 cm from the soil surface and was surrounded with polythene sheet up to 60 cm deep inside the soil in order to restrict lateral subsurface flow of irrigation water.

Following irrigation treatments were applied in the plots:

$I_o$ = No irrigation;
$I_1$ = Irrigation at 15% depletion of available soil water;
$I_2$ = Irrigation at 30% depletion of available soil water;
$I_3$ = Irrigation at 45% depletion of available soil water;
$I_4$ = Irrigation at 60% depletion of available soil water.

## Irrigation

Irrigation requirements (time and quantity) were determined on the basis of soil moisture status in each treatment. Soil moisture was measured by neutron-scattering method using a neutron probe manufactured by Nucletronics Aps, Metalbuen 20B, 2750 Ballerup Copenhagen, Denmark. This method of soil moisture measurement uses a source of fast neutrons which is lowered into an aluminum access tube in the soil. Once calibrated, the device is easily and quickly used.

Neutron probe was calibrated and, the field capacity and critical moisture levels were calculated in order to estimate the time and quantity of irrigation water. Detail procedures are described in this section.

### Determination of field capacity and calibration of neutron probe

A calibration plot of 2.0 m X 1.0 m size was selected at a corner of the experimental field in order to determine the field capacity. The plot was surrounded by 15 cm high bund. Two access tubes were installed in the calibration plot which was then flooded for several hours, allowing water to infiltrate into the soil. As a result, the upper soil became saturated to some depth due to continuous infiltration. When the water on the surface just receded, the plot was covered by a polythene sheet to prevent evaporation. In order to monitor soil moisture changes, 12 hourly reading of neutron probe was taken at depths of 10, 20, and 30 cm, through the access tubes. The initial readings, in terms of counts, corresponded to saturated condition, and were large in order of magnitude. However, these values gradually became smaller, as the gravitational water drained down. After two days, counts attained a static value, indicating that the field capacity was reached. This value of count (count = 410) was taken for field capacity.

Then the polythene cover was removed from the calibration plot and the soil was allowed to dry by evaporation. Thereafter, neutrone probe readings accompanied by soil samples were taken at intervals of several days. Moisture contents of the collected samples were determined by gravimetric method. Series of neutron probe counts, thus obtained, constitute the x values, and the corresponding soil moisture contents (SMC) the Y values, of the calibration equation defined by

$$Y = a + bx \quad .....(1)$$

The X and Y values are presented in Table 2. Constants a and b of eq..... (1) are determined by least squares regression.

From least squares regression.

$$b = \frac{\Sigma xi\ yi}{\Sigma xi^2} = 0.065$$

and, $a = \bar{y}_i - b\bar{x}i = 0.168$

The equation becomes

$$y = a + bx = 0.168 + 0.065x \quad ..... (2)$$

Soil moisture content (SMC) at field capacity was calculated from eq..... (2) using corresponding neutron probe count of 410 to be 26.8 percent on dry weight basis.

TABLE 2 . Values of neutron probe counts and corresponding soil moisture content (SMC) in percent.

| Counts x | SMC(%) y |
|---|---|
| 340 | 22.27 |
| 376 | 24.61 |
| 439 | 28.70 |
| 402 | 26.30 |
| 337 | 22.07 |

**Calculation of critical level of moisture**

The soil of the experimental plot was sandy loam with field capacity, as determined, of 26.8 percent. In respect of wilting point, a value of 18.0 percent was assumed for this texture (Bruce and Vipond, 1974).

So,

Soil moisture at field capacity (FC) = 26.8 percent.

Soil moisture at wilting point (WP) = 18.0 percent.

Available water (AW) range = FC to WP

= 26.8 to 18.0 percent.

Critical level of moisture for treatment $I_1$, allowing 15% depletion of available water from field capacity becomes :

FC - (FC-WP) X 15/100

or 26.8 - (26.8-18.0) X 0.15

or 25.48 percent (by weight)

Similarly, percent critical level of moisture for $I_2$(30% depletion of available water), $I_3$ (45% depletion of available water) and $I_4$ (60% depletion of available water)treatments were calculated to be 24.26, 22.84 and 21.52 percent (by weight), respectively.

**Time and amount of irrigation water**

Regular neutron probe reading was taken at 3 days interval from transplanting to harvest for estimating time and quantity of irrigation. Time of irrigation of any specific treatment was determined from the critical moisture level of that treatment. Plots in a treatment were irrigated only when the soil moisture status reached or fell just below its critical level.

Amount of water to be applied in each irrigation, in a treatment, was considered to be equal to the allowable soil moisture depletion (SMD) of that treatment. Allowable SMD, in terms of depth, was calculated from the root zone depth of onion and critical soil moisture level, using following equation :

$$d = \frac{(M_1 - M_2) \times D \times A}{100} \times 10$$

Where,

$d$ = Allowable soil moisture depletion (mm).

$M_1$ = Soil moisture content at field capacity (percent).

$M_2$ = Critical soil moisture level of a treatment (percent).

$D$ = Depth of soil to be wetted (assumed root zone depth, cm ).

$A$ = Soil bulk density ($g/cm^3$).

10 = Conversion of cm to mm.

In this study, root zone depth of 40 cm was assumed for onion.

**Calculation of total water use**

The total water use (TWU) of onion (consumptive use of water) was calculated from the total amount of irrigation, the effective rainfall received during the growing season and the soil moisture contribution. This may be expressed by the following relationship :

$$TWU = IR + ER + S$$

Where,

TWU = total water use(mm);

IR = total irrigation water applied (mm);

ER = effective rainfall (mm);

S = soil water (mm).

Effective rainfall is defined as that portion of measured rainfall which is effectively used by the plants in each treatment. If the amount of rainfall is more than the prevailing SMD, the plant will use only a part to cover the depletion. However, if the rainfall is less than depletion, the total rainfall will be effectively used. The effective rainfall in different treatments were determined and presented in Appendix 2.

Soil water is defined as the reserve water in the soil. The quantity of soil water used by the crop in each treatment was calculated by subtracting the prevailing soil moisture reserve in the root zone at the time of harvest from that prevailing at the time of transplanting.

## Harvesting

The mature crop was harvested on 6 April 1990. The maturity of the crop was ascertained by the sign of drying out of most of the leaves and the collapse at the neck of the top.

## Data Collection

Data were collected on the following characters.

1. Number of leaves per plant
2. Height of plant (cm)
3. Percent of split bulb
4. Percent plant bolting
5. Diameter of bulb (cm)
6. Weight of bulb per plant (g)
7. Yield of bulb per plot (kg)
8. Yield of bulb per hectare (ton)

## Statistical analysis

The data on various plant characters were statistically analyzed to find out the level of significance in the variation resulted from the experimental treatments. The means of all treatments were calculated and the differences between treatment pairs were compared by LSD test.

# CHAPTER IV

# RESULTS

This chapter deals with the experimental results. Soil moisture status, total water use by the crop and the response of plant characters to different irrigation treatments are presented in this section.

## Soil moisture status, irrigation and total water use

The moisture status of the experimental plots varied depending upon supplemental irrigation or natural rainfall. Higher moisture content of soil was observed as and when it received water from rainfall or irrigation. The reserve soil water was observed to be used in a relatively higher amount in the plots under 45% and 60% depletion regimes. Irrigation, in the present study, was designed to apply at 15, 30, 45 and 60% depletion of available soil moisture. Under the present experimental condition 15% and 30% depletion of available soil moisture started at 18 and 24 days after transplanting, respectively. Up to 68 days from transplanting, four irrigations were required in 15% depletion regime, while two irrigations were required in 30% depletion regime. The total quantity of water applied were 60 and 40 mm in 15% and 30% depletion regimes, respectively. Experimental plots under 45% and 60% depletion regimes never reached to the required critical level and therefore, no irrigation was required to apply.

This happened primarily because of supplemental water from natural rainfall. The total water use was maximum in 30% depletion regime (200.2 mm) which was closely followed by 15% depletion regime (195.2 mm). It was lowest (141.2 mm) in the non irrigated plots. The total water used from various sources under different irrigation regimes are presented in Figure 1.

**Effects on growth and yield**

Analysis of variance of the data on growth and yield of onion in response to irrigation levels are presented in Table 3. There was a noticeable effect of irrigation regimes on the plant growth and yield (Table 4). The number of leaves per plant varied significently with the irrigation treatments. Irrigation at 15% and 30% depletion regimes increased the number of leaves per plant. Maximum number of leaves per plant (11.58) was obtained in 15% depletion regime and the minimum number of leaves (8.32) was observed in no irrigation regime.

The height of plant was improved by application of irrigation water. Maximum plant height (43.03 cm) was obtained by irrigation at 30% depletion which was statistically similar to the plant height produced by irrigaiton in 15% depletion of available soil moisture.

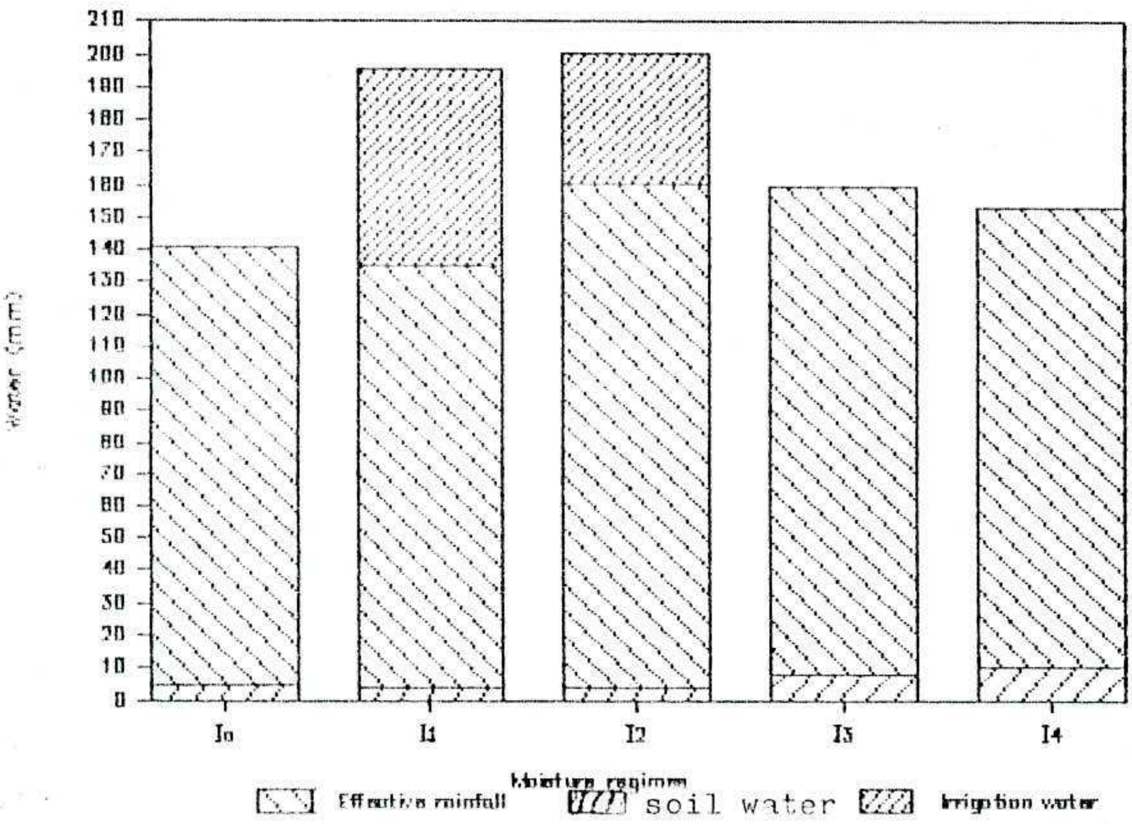


Fig. 1. The total quantity of water used from various sources under different irrigation regimes.

$I_0$ = No irrigation;
$I_1$ = Irrigation at 15% depletion of available soil water;
$I_2$ = Irrigation at 30% depletion of available soil water;
$I_3$ = Irrigation at 45% depletion of available soil water;
$I_4$ = Irrigation at 60% depletion of available soil water.

TABLE 3. Analysis of variance of different characters on onion

| Source of variation | D.F. | Mean Sum of square | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. of leaves/ plant | Plant height (cm) | % of split bulb /plot | % plant bolting /plot | Diameter of blub /plant (cm) | Weight of bulb/ plant (g) | Yield of bulb/ plot (kg) | Yield of bulb/ ha (ton) |
| Replication | 2 | 5.02** | 2.81 | 18.04 | 2.83 | 0.43** | 9.79 | 0.22 | 2.49 |
| Treatment | 4 | 5.65* | 10.91* | 65.43* | 0.48* | 0.46* | 20.54* | 0.47* | 5.19* |
| Error | 8 | 0.87 | 2.70 | 12.05 | 0.104 | 0.08 | 4.03 | 0.08 | 0.99 |

* indicates significant at 5% level

** indicates significant at 1% level

TABLE 4. Effects of irrigation regimes on different characters of onion

| Irrigation regimes | No. of leaves /plant | Plant height (cm) | % split bulb/ plot ‡ | % plant bolting /plot ‡ | Diameter of bulb (cm) | Weight of bulb /plant (g) | Yield of bulb /plot (kg) | Yield of bulb /ha (ton) |
|---|---|---|---|---|---|---|---|---|
| $I_0$ | 8.32 | 38.37 | 24.86 (17.7) | 3.25 (10.8) | 3.8 | 19.43 | 2.91 | 9.71 |
| $I_1$ | 11.58 | 41.83 | 33.47 (30.53) | 4.31 (19.07) | 4.54 | 25.96 | 3.9 | 12.96 |
| $I_2$ | 10.22 | 43.03 | 34.77 (32.7) | 3.66 (13.8) | 4.52 | 25.17 | 3.87 | 12.60 |
| $I_3$ | 9.17 | 40.88 | 27.66 (21.7) | 3.44 (3.44) | 3.74 | 24.58 | 3.68 | 12.28 |
| $I_4$ | 8.44 | 39.17 | 25.09 (18.2) | 3.67 (13.8) | 3.94 | 22.61 | 3.38 | 11.28 |
| Level of significance | $P<0.05$ | $P<0.05$ | $P<0.05$ | $P<0.05$ | $P<0.05$ | $P<0.05$ | $P<0.05$ | $P<0.05$ |
| LSD (0.05) | 1.76 | 3.09 | 6.52 | 0.48 | 0.54 | 3.94 | 0.53 | 1.8 |

‡ Analysis was carried out after transformation of data. Figures in the parenthesis are original values

$I_0$ = No irrigation;

$I_1$ = Irrigation at 15% depletion of available soil water;

$I_2$ = Irrigation at 30% depletion of available soil water;

$I_3$ = Irrigation at 45% depletion of available soil water;

$I_4$ = Irrigation at 60% depletion of available soil water.

Irrigation was observed to increase the occurance of bulb splitting. Highest percentage of split bulb (32.77%) was produced at 30% depletion regime, which was followed closely by the 15% moisture regime (30.5%). A higher proportion of bolting (19.07%) was found at 15% depletion regime.

The diameter of bulb was maximum (4.54 cm) in 15% depletion regime which was statistically similar to the 30% depletion regime. Lowest bulb diameter (3.74 cm) was obtained from 45% depletion regime which was statistically similar with 60% depletion regime and no irrigation treatment.

Maximum weight of bulb per plant (25.96 g) was obtained by irrigation at 15% depletion of available soil moisture, followed by irrigation at 30% and 45% depletion regimes. Lowest bulb weight per plant (19.43 g) was recorded from control treatment.

Irrigation at 15% depletion produced maximum yield of bulb per plot (3.9 kg). However, statistically similar yields of bulb per plot were also produced in 30, 45 and 60% depletion regimes. The lowest yield of bulb per plot (2.9 kg) was obtained at no-irrigation regimes.

Maximum yield of bulb per hectare (12.96 t) was found in 15% depletion regime which was about 33.5% higher than the control treatment. The second highest yield (12.6 t/ha) was obtained from 30% depletion regime. Yield from 45% [illegible] depletion regime was also considerably high with significant differance from non-irrigated plots.

# CHAPTER V

# DISCUSSION

The results of the present investigation revealed that onion cv. Faridpur Bhati would respond positively to irrigation for the production of bulbs. Several authors have studied the effects of frequency of irrigation and attempted to quantify the irrigation requirement in onion (Karim *et al.*1981.; Achar *et al.* 1984.; Palled *et al.* 1988). Frequency and quantity of irrigation were found to be variable dependig upon cultivar and the geographical locations (Uzrad *et al.* 1975.; El-Kalla and El-Kassaby, 1985.; Hedge, 1986; and Golbiatti and Castellane, 1990). In the present experimental condition, highest yield was obtained by irrigation at 15% depletion of available soil moisture. However, the yield did not differ statistically from 30% and 45% depletion regimes. The yield from 60% depletion regime was also very high. No irrigation was required in 45% and 60% depletion regimes.

The water used in these two regimes came from two sources viz. rainfall and reserve soil water. It was observed that the plots under 45% and 60% depletion regimes had a higher soil water value which probably contributed to an increased yield. It was probable that these plots were affected by underground seepage from a nearby irrigation channel, thus increasing their soil water content. However, it is not possible to establish this conjecture with the data of present investigation. It can be suggested that in any future work seepage problem may probably be avoided by selecting the experimental field far from an irrigation channel or away from any field which gets irrigation. It should also be mentioned here that a controlled environment may be more appropriate for a study like this to estimate optimum moisture level and frequency of irrigation, although several studies have been done in open environment with different crops (Winter, 1952.; Orzolek and Carrol, 1978.; Choi *et al.*, 1980. ; Karim and Khan, 1980.; Rashid and Mannan, 1986; and Rahman *et al.*, 1989). Provision of temporary cover may be arranged to protect experimental plots from natural rainfall. However, results of the present investigation indicated that irrigation at 15% and 30% depletion regimes would promote bulb yield, if water from rain or other sources was not available. It may be appropriate to mention that further studies should be carried out in order to quantify not only the frequency but also the depth of irrigation.

# CHAPTER VI

## SUMMARY

The experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from November 1989 to April 1990. The experiment was carried out to study the response of onion to different moisture regimes. There were five irrigation treatments viz. no irrigation, irrigations at 15%, 30%, 45% and 60% depletion of available soil water. The treatments were replicated three times in randomized block design.

Soil moisture status of the experimental plot was monitored with neutron probe. The soil of the experimental plot was sandy loam and its bulk density was 1.6 g/cm$^3$. The field capacity of this soil was determined to be 26.8 percent. Soil moisture status of the experimental plots varied depending upon supplemental irrigation or natural rainfall. Frequency of irrigation was regulated by effective rain and soil water. During the growing period of onion, experimental plots under 45% and 60% depletion regimes never reached the required critical level, and therefore, no irrigation was required to apply in those plots. Irrigation was applied under 15% and 30% depletion regimes and the total quantities of water applied were 60 mm and 40 mm, respectively. The total water use was maximum (200.2 mm) in 30% depletion regime which was closely followed by 15% depletion regime (195.2 mm). It was lowest (141.2 mm) in non-irrigated plots.

Maximum number of leaves per plant (11.58) was produced in 15% depletion regime, while number of leaves was lowest (8.32) in no irrigation regime. Irrigation at 30% depletion produced the maximum height of plant (43.03 cm) which was closely followed by irrigation at 15% depletion of available soil moisture. Occurance of split bulbs and bolting were higher under irrigated condition. Size of the bulb increased with irrigation. The largest size (4.52 cm) and the maximum weight of bulb per plants (25.96 g) was recorded by irrigation at 15% depletion of available soil moisture. Highest yield of bulb per hectare (12.96 t) was obtained in 15% depletion regime which was statistically similar to the yield of bulb per hectare in 30% and 45% depletion regimes.

## REFERENCES


Anonymous. 1990. Daily weather report. Meteorological Service Section, BAU, Mymensingh.

Achar, H.P.; Patil, V.S.; Dreddy, M.R.; and Ansari, M.R. 1984. Effect of moisture regimes and fertilizer levels on yield of onion. Current research, 13(4-6) : 29-30.

BBS. 1987. Year book of Agricultural Statistics of Bangladesh. Statistics Division, Ministry of Planning, Government of Peoples' Republic of Bangladesh, Dhaka. p.113.

Battilani, A. and Lanzoni, L. 1987. Onion irrigation : determination of watering volumes and intervals. Irrigazione e Drenaggio, 34(2) : 11-16.

Bruce, W. and Vipond, S. 1974. Irrigation: Design and Practice, Batoford Academy and Educational Limited, London. p.71.

Bottcher, H.; Frohlich, H.; and Hubner, C. 1979. Results regarding the complex influence of sprinkler irrigation, plant density and fertilization on yield, quality and storage quality of onion I. Influence on yield and quality. Achive fur Gartenbau, 27(6) : 283-306.

Barnoczki, A. 1981/82. Effect of irrigation on the variability of onion cultivars. Zoldsegtermesztesi Kutato Intezet Bulletinje, 15 : 15-25.

Chaudhry, A. B. and Erinne, E.C. 1984. Determination of optimum irrigation frequency for onion in Kaini Nigeria Savana. Gartenbauwissenschaft, 49(3) : 117-121.

Choi, J.K.; Ban, C.D. and Kwon, Y.S. 1980. Research Report of Horticulture and Service of Korea, 22: 20-23. (Cited from Bose, T.K. and Som, M.G. 1986. Vegetables Crops in India. Ist Edn. Nayaprakash, Calcutta, India. p. 593).

Dastane, N.G.; Prasher, K.S. and Yusuf, M.Y. 1969. Annual Report, IARI, New Delhi. (Cited from Bose, T.K. and Som, M.G. 1986. Vegetables Crops in India. Ist Edn. Nayaprakash, Calcutta, India. p. 564).

El-Kalla, S.E., El-Kassaby, A.T. 1985. Yield and quality of onion bulbs as effected by different number of irrigations and system of nitrogen application. Journal of Agricultural Science, 10(1) · 1-6.

FAO, 1983. FAO Production year book. Food and Agricultural Organization of the United Nations, Rome. pp. 167-168.

FAO, 1988. FAO Production year book. Food and Agricultural Organization of the United Nations, Rome. 42 : 190-193.

Galbiatti, J.A. and Castellane, P.D. 1990. Effect of irrigation and of mineral and organic fertilizer on the onion cultivars piralopes. Horticulture Brasileira, 8(1) : 24.

Hedge, D.M. 1986. Effect of irrigation regimes on dry mater production, yield, nutrient uptake and water use of onion. Indian journal of Agronomy, 31(4) : 343-348.

Karim, I., Khan, M.S. and Rahaman, M. 1981. Water use by onion in grey terrace soil. Bangladesh Horticulture, 9(1-2): 61-64.

Karim, Z. and Khan, M.S. 1980. Response of cabbage to irrigation in red brown soil. Bangladesh Horticulture, 8(1) : 1-5.

Narang, R. S. and Dastane, N.G. 1969. Water use by *Allium cepa* L. (bulb onions) grown under different soil moisture regimes. Indian Journal of Horticulture, 26 : 176-180.

Orzolek, M.D. and Carrol, R.B. 1978. Yield and secondary root growth of carrots as influenced by tillage system, cultivation and irrigation. Journal of American Society for Horticulture Science, 103(2) : 236-239.

Palled, Y. B.; Kachapur, M. D.; Chandrasekharaiah, A. M. and Prabhakar, A. S. 1988. Response of onion to irrigation and nitrogen. Indian Journal of Agronomy, 31(1) : 22-25.

Purseglove, J. W. 1972. Tropical Crops (Monocotyledons-1). Longman Group Limited, London. pp:32-50.

Prashar, K. S. 1976. Effect of soil water stress at different stages of growth on yield of onion bulb. Indian Journal of Agronomy, 12 : 489-490.

Rabbani, M. G.; Hossain, A.; Siddique, M. A. and Faruque, A. M. 1986. Yield and storability of seven onion (*Allium cepa* L.) cultivars. Bangladesh Journal of Agriculture, 11(4) : 1-8.

Rashid, M. and Mannan, M.A. 1986. Cultivation of sweet potatoes. Annual Report of Root Crop Project, BARI, Joydebpur, Gazipur.

Rahman, M.A.; Guha, D.; Golder, P.C. and Sattar, M.A. 1989. Effect of irrigation and mulch on the growth and yield of cabbage in the hilly region. Bangladesh Horticulture, 17(1): 37-39.

Uzrad, M.; Goldberg, D.; Rimon, D.; Loobish, S. and Shechar, V. 1975. Irrigation of onion in the Araba desert by drip, spray and sprinkler method. Special publication, Agricultural Research Organization Volcanic centre. 1975. Israil. 46(5) : 32-38. Abstracts on tropical Agriculture 3, 14034. (Cited from Horticulutre Absrtact 9326, 1977).

Winter, E.J. 1952. Irrigation experiments with radishes. Annual Report of National Vegetable Research Station. Wellesbourne, 53 : 32-40.

Appendix 1. Daily pan evaporation, rainfall and humidity during the growing period of orion

| Month | January,90 | | | February,90 | | | March,90 | | | April,90 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days | Pan eva-poration (mm) | Rain-fall (mm) | Humi-dity (%) | Pan eva-poration (mm) | Rain-fall (mm) | Humi-dity (%) | Pan eva-poration (mm) | Rain-fall (mm) | Humi dity (%) | Pan eva-poration (mm) | Rain-fall (mm) | Humidity (%) |
| 01 | 2.7 | - | 77 | 4.6 | - | 67 | 3.3 | 9.8 | 80 | 3.5 | 1.8 | 82 |
| 02 | 3.1 | - | 78 | 3.5 | - | 74 | 3.1 | - | 74 | 3.7 | - | 81 |
| 03 | 2.2 | - | 77 | 5.1 | - | 65 | 2.7 | - | 63 | 3.5 | - | 71 |
| 04 | .8 | - | 83 | 2.7 | - | 67 | 3.8 | - | 70 | 3.4 | - | 79 |
| 05 | 2.1 | - | 83 | 2.3 | - | 70 | 4.1 | - | 65 | 4.2 | 31.00 | 78 |
| 06 | 1.4 | - | 74 | 3.4 | - | 65 | 2.6 | - | 80 | 4.3 | - | 75 |
| 07 | 2.8 | - | 80 | 4.2 | - | 71 | 2.2 | - | 76 | 3.2 | - | 79 |
| 08 | 2.5 | - | 79 | 2.4 | - | 70 | 4.4 | - | 67 | 3.3 | 0.2 | 80 |
| 09 | 2.5 | - | 77 | 2.8 | - | 72 | 4.0 | 1.6 | 70 | 6.0 | - | 88 |
| 10 | 2.3 | - | 75 | 3.3 | - | 68 | 2.6 | 1.0 | 71 | 5.0 | - | 65 |
| 11 | 1.4 | - | 78 | 3.5 | - | 71 | 3.0 | - | 71 | 4.6 | - | 77 |
| 12 | 1.4 | - | 75 | 3.0 | - | 75 | 2.6 | 18.6 | 87 | 5.7 | - | 82 |
| 13 | 3.1 | - | 80 | 2.1 | - | 79 | 1.9 | - | 79 | 5.2 | - | 83 |
| 14 | 1.9 | - | 75 | 3.6 | 5.3 | 90 | 3.5 | - | 72 | 6.9 | - | 84 |
| 15 | 2.5 | - | 80 | 3.7 | 14.0 | 81 | 4.4 | - | 74 | 7.1 | - | 79 |
| 16 | 2.3 | - | 79 | 4.5 | 11.5 | 80 | 4.6 | - | 72 | 6.2 | - | 78 |
| 17 | 2.3 | - | 77 | 1.9 | - | 76 | 3.9 | - | 69 | 7.7 | 22.2 | 79 |
| 18 | 1.3 | - | 78 | 3.9 | - | 71 | 5.1 | - | 70 | 5.3 | 1.7 | 81 |
| 19 | 2.1 | - | 83 | 1.7 | - | 83 | 3.6 | - | 68 | 5.5 | 6.0 | 83 |
| 20 | 1.3 | - | 80 | 2.4 | - | 80 | 5.2 | - | 76 | 3.0 | 0.3 | 85 |

(Appendis 1. continued)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 1.4 | - | 80 | 5.5 | 25.0 | 75 | 5.4 | - | 72 | 6.0 | - | 88 |
| 22 | 2.0 | - | 85 | 4.4 | 25.0 | 79 | 3.5 | - | 83 | 4.9 | - | 85 |
| 23 | 1.4 | - | 85 | 4.5 | - | 73 | 3.5 | - | 78 | 4.7 | 2.0 | 88 |
| 24 | 1.7 | - | 86 | 3.5 | - | 75 | 3.8 | 4.2 | 88 | 6.2 | 18.6 | 80 |
| 25 | 1.2 | - | 84 | 2.1 | 1.1 | 79 | 1.5 | 27.0 | 86 | 7.3 | 11.8 | 79 |
| 26 | 1.7 | - | 80 | 2.6 | - | 84 | 2.7 | - | 73 | 5.7 | 5.0 | 80 |
| 27 | 1.7 | - | 76 | 1.8 | - | 82 | 3.2 | - | 76 | 3.9 | - | 81 |
| 28 | 1.6 | - | 81 | 3.5 | 1.0 | 75 | 3.0 | - | 78 | 4.9 | 0.6 | 84 |
| 29 | 1.8 | - | 77 | - | - | - | 3.3 | 1.8 | 83 | 5.2 | 0.6 | 83 |
| 30 | 2.1 | - | 71 | - | - | - | 5.0 | - | 78 | 5.2 | - | 77 |
| 31 | 3.1 | - | 64 | - | - | - | 3.5 | 1.0 | 81 | - | - | - |

* (Anonymous, 1990)

Appendix 2. Estimation of effective rainfall during the growing period of onion

| Date of rainfall | Quantity of rainfall (mm) | Treatments: $I_0$ Cal. of SMC Prior to rainfall (%) | $I_0$ Soil Moisture depletion (SMD) (mm) | $I_0$ Effective rainfall (mm) | $I_1$ Cal. of SMC prior to rainfall (%) | $I_1$ SMD (mm) | $I_1$ Effective rainfall (mm) | $I_2$ Cal. of SMC prior to rainfall (%) | $I_2$ SMD (mm) | $I_2$ Effective rainfall (mm) | $I_3$ Cal. of SMC prior to rainfall (%) | $I_3$ SMD (mm) | $I_3$ Effective rainfall (mm) | $I_4$ Cal. of SMC prior to rain fall (%) | $I_4$ SMD (mm) | $I_4$ Effective rainfall (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14.2.90 | 5.30 | 23.76 | 19.45 | 5.30 | 23.83 | 19.0 | 5.30 | 23.63 | 20.28 | 5.30 | 23.5 | 21.12 | 5.30 | 23.57 | 20.67 | 5.3 |
| 15.2.90 | 14.00 | 23.20 | 23.04 | 14.00 | 23.17 | 22.0 | 14.00 | 23.07 | 23.83 | 14.0 | 22.94 | 24.70 | 14.00 | 23.01 | 24.25 | 14.0 |
| 16.2.90 | 11.50 | 22.63 | 26.75 | 11.50 | 22.60 | 26.8 | 11.50 | 22.50 | 27.52 | 11.50 | 22.37 | 28.35 | 11.50 | 22.44 | 27.90 | 11.5 |
| 21.2.90 | 25.00 | 26.32 | 3.07 | 3.07 | 27.42 | - | - | 25.21 | 10.17 | 10.17 | 25.60 | 7.68 | 7.68 | 26.06 | 4.73 | 4.73 |
| 22.2.90 | 25.00 | 25.46 | 8.57 | 8.57 | 26.56 | 1.53 | 1.53 | 24.35 | 15.68 | 15.68 | 24.74 | 13.18 | 13.18 | 25.20 | 10.24 | 10.24 |
| 25.2.90 | 1.10 | 24.21 | 16.57 | 1.10 | 25.31 | 9.53 | 1.10 | 23.10 | 23.68 | 1.10 | 23.49 | 21.18 | 1.10 | 23.95 | 18.24 | 1.10 |
| 28.2.90 | 1.00 | 25.16 | 10.00 | 1.00 | 23.86 | 18.00 | 1.00 | 24.64 | 13.82 | 1.00 | 25.61 | 7.60 | 1.00 | 26.20 | 3.89 | 1.00 |
| 01.3.90 | 9.80 | 24.61 | 14.00 | 9.80 | 23.31 | 22.33 | 9.80 | 24.09 | 17.34 | 9.80 | 25.06 | 11.13 | 9.80 | 26.65 | 7.36 | 7.36 |
| 09.3.90 | 1.60 | 24.10 | 17.00 | 1.60 | 23.84 | 18.94 | 1.60 | 23.06 | 23.39 | 1.60 | 24.94 | 11.90 | 1.60 | 24.10 | 17.28 | 1.60 |
| 10.3.90 | 1.00 | 23.47 | 21.30 | 1.00 | 23.21 | 22.97 | 1.00 | 22.43 | 27.96 | 1.00 | 24.31 | 10.00 | 1.00 | 23.47 | 21.3 | 1.00 |
| 12.3.90 | 18.60 | 24.31 | 15.93 | 15.93 | 23.08 | 23.80 | 18.60 | 22.17 | 29.63 | 18.60 | 22.49 | 27.58 | 18.60 | 23.21 | 22.97 | 18.60 |
| 24.3.90 | 4.20 | 21.79 | 32.06 | 4.20 | 20.02 | 43.39 | 4.20 | 19.89 | 44.22 | 4.20 | 20.28 | 41.70 | 4.20 | 22.10 | 30.08 | 4.20 |
| 25.3.90 | 27.00 | 21.19 | 35.90 | 27.00 | 19.42 | 47.23 | 27.00 | 19.29 | 48.06 | 27.00 | 19.68 | 45.56 | 27.00 | 21.5 | 33.92 | 27.00 |
| 29.3.90 | 1.80 | 25.71 | 6.97 | 1.80 | 24.80 | 12.00 | 1.80 | 23.96 | 18.00 | 1.00 | 24.87 | 12.35 | 1.80 | 25.45 | 8.64 | 1.80 |
| 31.3.90 | 1.00 | 24.73 | 13.24 | 1.00 | 23.82 | 19.07 | 1.00 | 22.98 | 24.45 | 1.00 | 23.89 | 18.62 | 1.00 | 24.47 | 14.91 | 1.00 |
| 01.4.90 | 1.80 | 24.18 | 16.76 | 1.80 | 23.27 | 22.59 | 1.80 | 22.43 | 27.96 | 1.80 | 23.34 | 22.14 | 1.80 | 23.92 | 18.43 | 1.8 |
| 04.4.90 | 31.00 | 22.42 | 28.03 | 28.03 | 22.09 | 30.14 | 30.14 | 21.79 | 32.06 | 31.00 | 21.83 | 31.80 | 31.00 | 21.31 | 35.14 | 31.0 |

$I_0$, $I_1$, $I_2$, $I_3$ and $I_4$ are irrigation,irrigation at 15%,30%, 45% and 60%, respectively.