CHAPTER 3

MATERIALS AND METHODS

The present investigation was carried out in flood plain of Wadi Hashim, Ras El-Hekma Region, East Mersa Matrouh, Matrouh Governorate, North Western Coast of Egypt, during two winter growing successive seasons 2011/2012 and 2012/2013. Two field experiments were conducted to study the effect of the relationship between the strip size of water harvesting (catchment: cultivated area) and (mineral nitrogen and biofertilization) on growth, yield, yield components, chemical composition, water studies and economic evaluation of Giza 126 barley cultivar. The experiment included 30 treatments, which were the interaction between five treatments of strip sizes i.e. the ratio between water harvesting (catchment): cultivated area and six fertilizers, mineral nitrogen and biofertilizer [Microbein (*Psedomonnas sp.* + *Azotobacter sp.* + *Azosprillum sp.* + *Bacillus megaterium*)].

3.1. Strip Water Harvesting (Catchment): Cultivated Area:

Five treatments according to the relationship between cultivated and harvesting (Catchment) area. The cultivated area of the experimental unit was 6 m x 6 m (36 m2), the catchment area was different according to the following treatments i.e. 36, 72, 108 and 144 m2 as shown in Table (1).

Table (1): Strip size of water harvesting (catchment): cultivated area (m^2).

Relation between [1]H : [2]C	Harvesting (catchment) area (m^2)	Cultivated area (m^2)
1.1. Control	Without catchment area	36
1.2. 1 : 1	36 (6 x 6)	36
1.3. 2 : 1	72 (6 x 12)	36
1.4. 3 : 1	108 (6 x 18)	36
1.5. 4 : 1	144 (6 x 24)	36

[1] H = Harvesting (Catchment) area (m^2) and [2]C = Cultivated area (m^2)

3.2. Mineral Nitrogen and Biofertilization (Microbein):

3.2.1. Without mineral nitrogen and inoculation (control).
3.2.2. 10 kg N as NH_4NO_3 (33.5 % N)/fed.
3.2.3. 20 kg N as NH_4NO_3 (33.5 % N)/fed.
3.2.4. Biofertilization [Microbein (*Psedomonnas sp,* + *Azotobacter sp,* + *Azosprillum sp.,* + *Bacillus megaterium*)].
3.2.5. 10 kg N as NH_4NO_3 (33.5 % N)/fed. with biofertilization.
3.2.6. 20 kg N as NH_4NO_3 (33.5 % N)/fed. with biofertilization.

Source of biofertilization (Microbein): Agriculture Research Center, Giza, Egypt.

3.3. Meteorological Data:

Meteorological data were downloaded from http://trmm.gsfc.,Weather Under Ground, Best forecast, for the two growing seasons (temperature, relative humidity, dew point and wind speed) were shown in Tables (2a and b) for the first and the second seasons, respectively. The received precipitation during the two growing seasons 2011/2012 and 2012/2013 were shown in Table (3) and Fig (1).

3.4. Characteristics of the Experimental Site:

The experimental area, about 2.4 feddan (100×100 m^2), was selected within Wadi Hashim, East of Mersa Matrouh, North Western Coast of Egypt. The studied site has a flat to slightly undulated surface with a general slope towards the North West direction not exceeding 3% as shown in the experimental site contour map (Fig 2).

3.5. Soil Analysis:

Mechanical and chemical analysis for the soil of the experimental site was shown in Table (4).

Table (2a): Meteorological data of Mersa Matrouh location during 2011/2012 growing season.

Period	Temperature above 2m/C°			Dew Point (C°)			Relative humidity			Wind Speed (km/h.)
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
1-10/11/2011	22.9	15	18.6	13.7	9.7	11.8	77.6	49.6	63.8	11.5
11-20/11/2011	20.3	12.9	16.7	13.6	9.5	11.8	91.6	57.8	76	16.5
21-30/11/2011	19.1	10.9	15	12.4	8.4	10.8	93.9	56	75.4	11.4
1-10/12/2011	19.2	11.7	15.4	11.7	6.9	9.3	87.3	52.1	68	14.6
11-20/12/2011	19.9	10.8	15.1	11.8	7.2	9.5	87.9	51.5	70.3	11.0
21-30/12/2011	18.1	10.1	13.8	9.8	4.1	7.1	83.5	46.7	66.5	18.9
1-10/1/2012	17.9	9.8	13.5	8.7	4.2	6.4	84	45.1	67.1	23.9
11-20/1/2012	15.3	9.1	12	8.4	4.0	6.4	85.5	53.3	70.1	21.2
21-30/1/2012	17.3	9.5	13	9.5	3.8	7.2	83.7	48.5	68.5	24.7
1-10/2/2012	16.4	7.1	11.5	7.9	-0.5	3.8	84	40.6	62.6	19.8
11-20/2/2012	16.8	9.1	12.8	9	2	5.7	85.2	43	63.4	17.9
21-30/2/2012	17.6	10.5	13.7	10.6	5.6	8.2	88.9	50.2	70.7	19.5
1-10/3/2012	17.5	9.8	13.3	11.7	6.3	9.5	94.1	55	76.3	32.5
11-20/3/2012	18.2	12.4	15	9.1	3.3	6.6	70.6	42.3	57.7	24.5
21-30/3/2012	19.9	11.6	15.6	13.5	7.7	10.7	89.6	53.2	73.3	14.5
1-10/4/2012	23.6	14.6	19.1	14.3	7.6	11.7	88.3	40.8	65.5	18.5
11-20/4/2012	26.2	13.8	19.6	12.1	0	6.9	74	17.5	47.5	20.7
21-30/4/2012	23.4	13.9	18.7	15.7	9.4	12.8	91.1	44.4	69.7	13.9
1-10/5/2012	24.9	15.4	20.1	17.4	10.4	14.8	92	38.5	70.5	12.3
11-20/5/2012	25.5	17	21.4	17.3	11.3	14.9	87.2	40.1	66.6	16.8
21-30/5/2012	36.4	22.8	28.1	17.6	15.0	18.3	95	63.6	86.7	17.4

Source: http://trmm.gsfc.,Weather Under Ground, Best forecast (2011/2012).

Table (2b): Meteorological data of Mersa Matrouh location during 2012/2013 growing season.

Period	Temperature above 2m/C°			Dew Point (C°)			Relative humidity			Wind Speed (km/h.)
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
1-10/11/2012	26.7	18.8	22.6	19.9	15	17.9	91.5	51.9	74.4	15.5
11-20/11/2012	24.2	16.5	20.3	16.0	10.3	12.7	82.7	37.4	62.0	12.2
21-30/11/2012	22.8	14.2	18.4	15.6	10.9	13.4	94.6	47.9	75.2	13.5
1-10/12/2012	21.9	14.00	17.9	11.4	4.8	8.1	78.1	28.1	54.4	22.6
11-20/12/2012	19.6	11.1	15.5	11.7	4.5	7.9	82.3	37.5	62.1	25.4
21-30/12/2012	18.8	10.0	14.3	11.3	6.6	8.9	89.8	44.3	70.6	17.4
1-10/1/2013	16.3	9.5	12.6	11.5	5.4	8.1	91.5	47.1	73.5	37.0
11-20/1/2013	19.3	8.8	13.8	10.9	4.1	8.1	90.2	40.5	69.7	27.7
21-30/1/2013	19.7	9.4	14.5	10.6	2.5	6.6	85.5	31.8	61.3	19.7
1-10/2/2013	20.0	8.6	14.4	9.0	3.0	6.7	87.1	28.0	61.8	20.4
11-20/2/2013	18.9	8.8	13.8	8.7	3.1	6.1	84.7	32.6	60.9	18.4
21-30/2/2013	21.3	11.1	16.6	12	5.7	8.9	89.6	36.8	66.4	17.4
1-10/3/2013	19.0	11.4	15.7	11.1	6.7	9.1	86.8	40.4	66.6	19.2
11-20/3/2013	23.9	12.3	18.2	12.3	2.1	7.9	82.5	26.6	56.9	25.0
21-30/3/2013	24.3	12.2	18.4	12.7	5.8	9.4	83.1	31.3	60.0	22.2
1-10/4/2013	27.3	13.5	20.6	12.7	5.6	9.8	82.6	23.4	55.3	23.0
11-20/4/2013	20.9	11.4	16.3	13.1	7.6	10.6	88.7	42.7	67.2	16.9
21-30/4/2013	22.7	13.5	18.2	15.1	11.9	13.6	92.8	46.4	72.9	12.8
1-10/5/2013	24.7	15.7	20.3	17.8	13.4	15.7	91.1	49.2	72.5	13.2
11-20/5/2013	27.2	16.6	21.9	17.2	12.3	14.7	86.2	40.9	64.3	19.3
21-30/5/2013	30.6	18.5	24.6	18.5	5.8	14.6	84.3	34.5	60.5	18.3

Source: http://trmm.gsfc.,Weather Under Ground, Best forecast (2012/2013).

Table (3): The received precipitation (mm) during the two growing seasons.

Month growing season	Sep.	Oct.	Nov.	Dec.	Jan.	Fep.	Mar.	Apr.	May.	Total
2011/2012	1.0	0.3	49.0	57.1	1.3	5.3	3.8	0	0	117.8
2012/2013	0	2.9	15. 9	16.4	54.8	0	0	0.2	0	90.2

Source: http://trmm.gsfc.,Weather Under Ground, Best forecast (2011/2012 and 2012/2013).

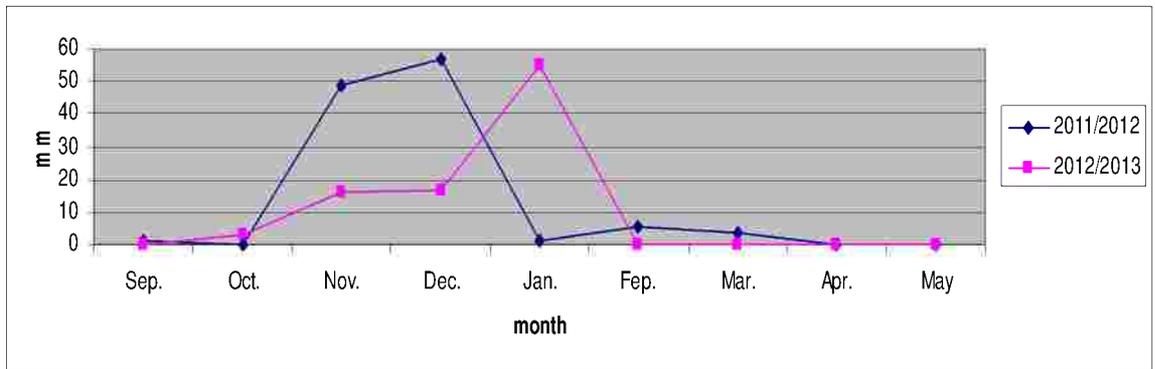Fig (1): Distribution of rainfall throughout the two growing seasons.

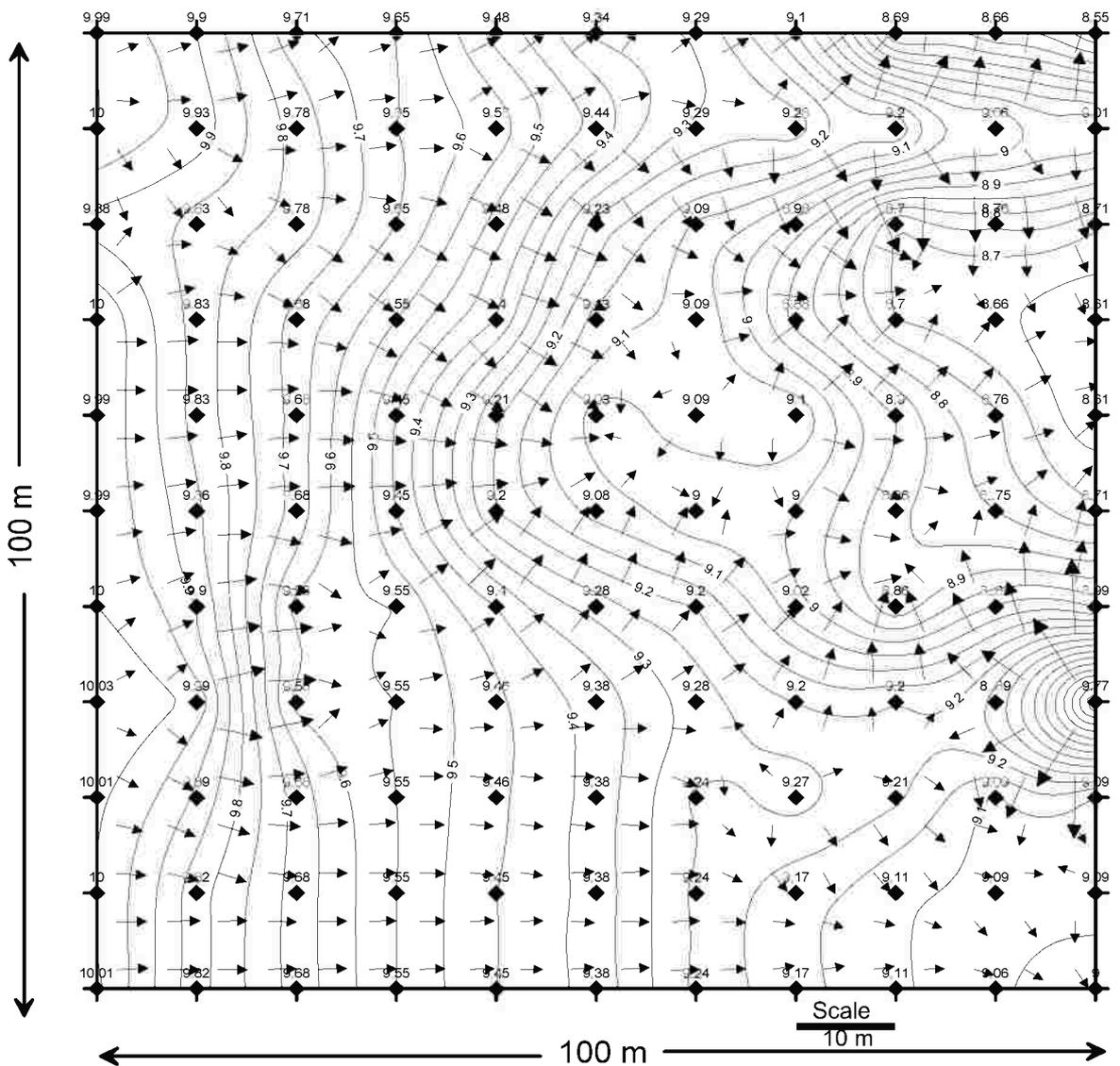Fig (2): Experimental site contour map in Wadi Hashem, East Mersa Matrouh.

Table (4): Mechanical and chemical analysis of the soil of the experimental site (0-15 and 15-30 cm).

Data Traits	Soil depth (cm)	
	0 - 15	15 - 30
Mechanical analysis		
Sand %	57	61
Silt %	28	27
Clay %	15	12
Texture class	Sandy loam	Sandy loam
$Caco_3$ %	15.9	26.1
Electric conductivity and pH		
EC, (ds/m)	0.85	1.6
pH	8.5	8.6
Chemical analysis		
a. Cations, (meq./L.)		
Ca^{++}	1.6	3.4
Mg^{++}	1.4	2.1
K^{++}	1.3	1.1
Na^+	4.5	10.0
b. Anions, (meq./L.)		
Co_3^-	—	—
HCo_3^-	2.2	4.3
Cl^-	4.6	10.8

Recorded data in Table (4) showed that, the soil texture was sandy loam at the two depths. This soil was salt free as indicated by the electrical conductivity values, while soil reaction was tended to be mildly alkaline. The cationic compositions were dominated by sodium, followed by Ca^{+2}, Mg^{+2}, and K^+, while the anions were dominated by chloride, followed by HCo_3^- and Co_3^-. Calcium carbonate content ranges from 15.90 to 26.10% and not accompanied by any secondary features of carbonate.

3.6. Agricultural Practices:

Barley grains were soaked in tap water for 24 hours, after air drying, the grains were divided in two parts, one of the two parts was treated with (microbein) and the other was not treated. For land preparation, cultivated area was plowed to rectangular times. The catchment area was prepared by cleaning surface soil, plowing, and compact the soil surface using special rolling. A level terrace, was constructed by gently sloping (3%), the catchment area serves as the cultivated area which stores the harvesting water. Each strip was divided into two parts: the upper part, referred to as the catchment area and the lower, down slope part called cultivated area and used as collector area when rain intensity exceeds the infiltration rate (IR) in the uncultivated areas. Some of the water flows downhill into the cultivated grains, where it is stored in the root zone.

Barley grains were sowed in 27 November 2011 and 3 December 2012 at a rate of 30 kg/fed. trough the first and the second seasons respectively. Grains were sown with

certain rate of the cultivated strip and the grains were covered. Small earth dikes were conducted between the strips to prevent rainoff water movements from one strip to another. The area of the experimental plot was 36 m^2 (6 m length and 6 m width, every plot with 6 rows, with wetness 15 cm between row to another).

Barley plants were harvested at 10 May 2012 and 24 April 2013 through the first and second seasons, respectively.

3.7. Sampling Technique:

Samples were randomly taken from four replicates after 56 day (tillering stage), 63 day (elongation stage) and 70 day from sowing (start of the boating stage and boating stage for first and second season, respectively).

The following growth characters were studied for the two seasons:
3.8. Growth Characters:
3.8.1. Plant height (cm).
3.8.2. Leaf area/m^2 (cm^2) = K (L x B). Whereas, K = Constant (0.75), L = leaf length and B = Maximum leaf width, according to the method recommended by (**Rad-Ford, 1967**).

3.8.3. Leaf area index (LAI) = $\dfrac{\text{Leaf area/plant}}{\text{Land area/plant}}$ according to (**Watson 1952**)

3.8.4. Specific leaf weight (SLW) (mg/cm^2) = $\dfrac{\text{Leaf dry weightin mg}}{\text{leaf area in cm}^2}$ according to (**Pearce et al. 1969**).

3.8.5. Total chlorophyll content of the leaves determined by chlorophyll meter (SPAD-502, soil plant analysis Department (SPAD) section, Minolta Camera Co., Osaka. Japan.
3.8.6. Relative growth rate (R.G.R.) (gm/gm/day) was calculated according to the formula suggested by (**Brown 1984**).
R.G.R. = Log W_1 - Log W_1 / T_2 - T_1, where:
(Log): Nobarian Log (W_2) and (W_1) for plant dry weight at the first (T_1), and at time two (T_2) corresponding days.

3.9. Yield, Yield Components and Water Relationship Studies:
3.9.1. Number of tillers/m^2.
3.9.2. Spike length (cm).
3.9.3. Number of spikes/m^2.
3.9.4. Number of spikelets/spike.
3.9.5. Number of grains/spike.
3.9.6. 1000 grain weight (g).
3.9.7. Grain yield (kg/fed.)
3.9.8. Biological yield (kg/fed.).
3.9.9. Straw yield (kg/fed.).
Grain, biological and straw yield were calculated from the whole plants of the experimental plot.
3.9.10. Harvest index (%) = Grain yield (kg/fed.)/ Biological yield (kg/fed.) x 100.
3.9.11. Tillering index (%) = Number of spikes per m^2/ Number of tillers per m^2.
3.9.12. Water use efficiency (WUE) = Grain yield (kg/fed.) / Eta (m^3/fed.) according to (**Giriappa 1983**).

3.10. Chemical Analysis:

Powder of grains was wet-digested with H_2SO_4-H_2O_2 digest (**Lowther 1980**) and the following determinations were carried out as fallows:

3.10.1. Phosphorus percentage (%) was determined by using Vanodomly phosphoric method (**Jackson 1967**).

3.10.2. Potassium percentage (%) was determined by using the Flam spectra-photometer according to (**Koch and Moowad 1977**).

3.10.3. Crude protein percentage (%): nitrogen percentage was determined by using the modified micro-Kjeldahl method as outlined according to the *A.O.A.C.* (**1980**)**, the protein content was determined by multiplying percentage of nitrogen x constant (6.25) according to (**Tripath** *et al.* **1971**).

3.10.4. Protein yield (kg/fed.) = protein percentage x grain yield (kg/fed.).

3.11. Economic Evaluation:

3.11.1. Return per feddan (L.E.) = Grain yield x Price + Straw yield x Price + Pasture (after crop harvested) x Price.

3.11.2. Net return per feddan (L.E) = Return per feddan – Costs (L.E).

The ratio between output return to the cost (input) = L.E./feddan. The cost data include costs of farm input, labor and farm machinery.

3.11.3. Investment ratio = Output L.E. / Input L.E.

3.11.4. L.E. return from using the cubic meter of rain water irrigation (L.E./m^3) = Grain yield price (L.E.)/Applied irrigation water (m^3).

3.12. Statistical Analysis:

The treatments were arranged and analyzed as a strip plot design according to (**Cochran** and **Cox** (**1963**) with four replicates, whereas the vertical strips were occupied by strip harvesting water and the horizontal strips were devoted to nitrogen and biofertilizer treatments, **New L.S.D.** test at the level of 5 % of significance was used for the comparison between means according to (**Waller** and **Duncan 1969**).