# CHAPTER 5

# RESULTS OF THE FIELD EXPERIMENT

## 5.1. Initial conditions of the field

Initial conditions that related to experiment were investigated and recorded. The preceding crop was soybean. Initial soil test was done in order to get information about some of soil physical and chemical properties. The results of soil tests presented in Table 13.

Table 13: Selected chemical and physical properties of the experiment field, MCC Chiang Mai, 2002.

| Indicator | Depth 0-15 cm | Depth 15-30 cm |
|---|---|---|
| pH (1:1) | 6.01 | 6.6 |
| OM % | 0.62 | 0.35 |
| N % | 0.039 | 0.025 |
| P (ppm) | 69.53 | 26.63 |
| K (ppm) | 31.0 | 36.0 |
| $Ca^{2+}$ (me/100 gm soil) | 2.06 | 2.25 |
| $Mg^{2+}$(me/100 gm soil) | 2.06 | 0.35 |
| Bulk density (gm/cm$^3$) | 1.72 | 1.79 |
| Particle density (gm/ml) | 2.58 | 2.58 |
| Porosity (%) | 33.27 | 30.89 |
| Texture | Sandy loam | Sandy loam |
| Sand (%) | 56.56 | 58.56 |
| Silt (%) | 26.40 | 24.00 |
| Clay (%) | 17.04 | 17.04 |

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Mean dry weights of three plants for above ground dry weight and root dry weight were 1.01 gm plant$^{-1}$, 0.27 gm plant$^{-1}$ respectively. Nitrogen content of above ground and under ground plant parts were 1.2 % and 0.97% respectively. Moreover, the mortality of transplanted plants in each treatment was recorded at the seventh day after transplanting when no more plant dies. The percentage of transplanted plant mortality at each nitrogen application under different water regimes was showed as mean of plant mortality, a week after transplanting (Table 14). The mortality was lowest at 100 kg N $ha^{-1}$ and the highest mortality was occurred at 400 kg N $ha^{-1}$ under rainfed.

Table 14: Mean mortality percentage of transplanted plants at nitrogen applications under different water management systems.

| Nitrogen rates | Mean of transplanted plants mortality (%) | |
|---|---|---|
| | Irrigation | Rainfed |
| 0 kg N $ha^{-1}$ | 0.00 | 0.00 |
| 100 kg N $ha^{-1}$ | 0.00 | 9.52 |
| 200 kg N $ha^{-1}$ | 4.76 | 42.85 |
| 400 kg N $ha^{-1}$ | 9.52 | 57.14 |

## 5.2. The response of sugarcane root

### 5.2.1. Dry matter

The results of analysis of variance for the root dry weight indicated that it had high significantly response to applied nitrogen fertilizer at all stages. Similarly, its response at different ($p<0.05$) water management system was significant at all stages, except 100 DAS (Table15). The interaction of nitrogen and soil water regimes was significant at 70, 85 DAS and it was not significant at 40, 55 and 100 DAS. Generally, the significant response of root dry weight was effected by both of nitrogen and soil moisture.

Sugarcane response to nitrogen was showed negatively with increasing rate of nitrogen application at the first two stages (40 and 55 DAS) in term of root dry weight in observed soil volume. The positive response was found at the later stages. However, the responses of sugarcane in dry matter accumulation at the highest application rate was still lack behind to none application level under rainfed system, up to 85 DAS (Figures 3 and 4).

Table 15: Analysis of variance for root dry weight (gm $hill^{-1}$) in observed soil volume ($6000\ cm^3$) at observed stages.

| Source of variation | Significant levels at observed stage (DAS) | | | | |
|---|---|---|---|---|---|
| | 40 | 55 | 70 | 85 | 100 |
| Replication (B) | ns | ns | ns | ns | ns |
| Water (W) | * * | * | * | * | ns |
| Nitrogen (N) | * * | * * | * * | * * | * * |
| W * N | ns | ns | * * | * * | ns |
| CV % W | 8.12 | 10.48 | 25.14 | 51.66 | 57.02 |
| CV % N | 12.33 | 12.86 | 12.12 | 21.79 | 25.15 |

* indicates significant at 0.05 % level

** indicates significant at 0.01 % level

ns indicates not significant

The trends of dry matter accumulation of root in observed soil volume, under different water management systems were obviously different. The dry weight had rapidly increased in irrigation system. Its growth had switched to boom up since 55 DAS at all nitrogen application. In rainfed system, root dry weight in observed soil volume had slowly increased, however, sharply increase was found at all nitrogen applications at 100 DAS. Gradual increase was found at none application in both water management systems (Figure 4).

In general, root dry weight at all nitrogen applications was greater than none application in both water management systems. The maximum root dry weight was finally recorded at 200 kg N $ha^{-1}$ in irrigation system (9.69 gm $hill^{-1}$) and at 100 kg N $ha^{-1}$ in rainfed system (4.05 gm $hill^{-1}$). At final stage (100 DAS), the root dry weight was not significant difference between 200 kg N $ha^{-1}$ and 100 kg N $ha^{-1}$ in LSD comparison.

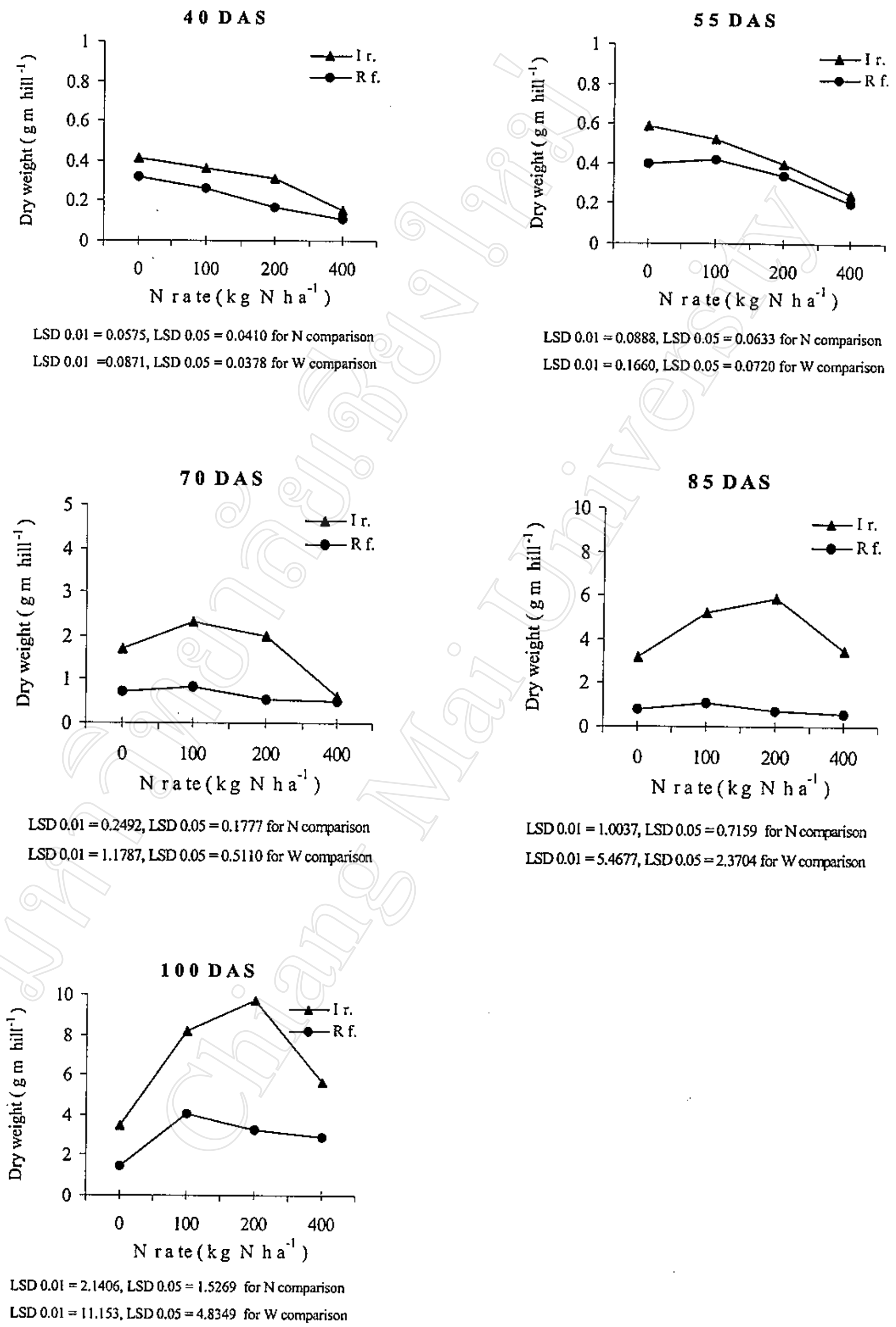



Figure 3: Sugarcane root dry weight (gm hill$^{-1}$) in observed soil volume response to nitrogen rates at different stages under irrigation system (-▲-) and rainfed system (-●-), where; N refers to nitrogen and W refers to water system for LSD comparison.

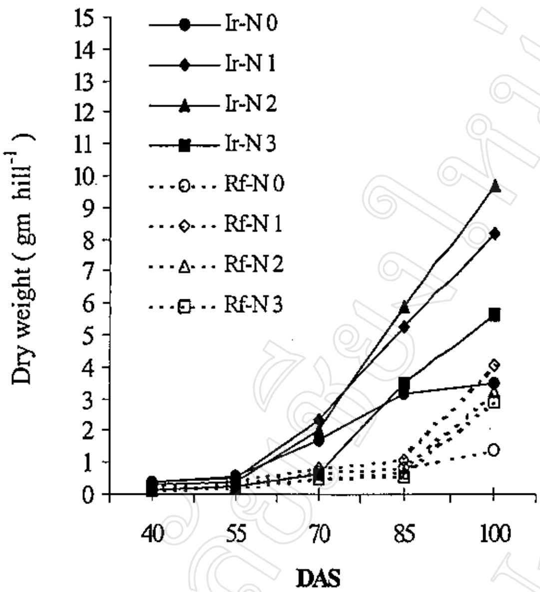



Figure 4: Dry matter accumulation of sugarcane root in observed soil volume over the observation period, at nitrogen applications under irrigation system(-▲-) and rainfed system (-•- )where N0,N1,N2, N3 refers as 0,100,200,400 kg N $ha^{-1}$, respectively.

### 5.2.2. Root length, root density, and its distribution pattern

Root-length, including estimation measurement for root hairs at different soil layer under different moisture was measured at each stage. The analysis of variance for total root density (Table 16) indicated that extent of root was significantly responded to the rates of applied nitrogen fertilizer, but also to water management systems at all stages ($p<0.05$). However, their interaction effect was not significant at 40 and 55 DAS. The record (Table 17) indicated that total mean of root-length was greatly different between irrigation-system and rainfed-system. Root extent and its density had evenly distributed at all observed layers in the irrigated system (Figure 5).

Table 16: Analysis of variance for total root density (cm $cm^{-3}$) in observed soil volume (6000 $cm^3$).

| Source of variation | Significant levels at observed stage (DAS) | | | | |
|---|---|---|---|---|---|
| | 40 | 55 | 70 | 85 | 100 |
| Replication (B) | ns | ns | ns | ns | ns |
| Water (W) | * * | * * | * | * * | * |
| Nitrogen (N) | * * | * * | * * | * * | * * |
| W x N | ns | ns | * | * | * * |
| CV % W | 12.31 | 5.88 | 26.24 | 22.31 | 44.20 |
| CV % N | 7.78 | 12.89 | 21.68 | 25.95 | 18.77 |

* indicates significant at 0.05 % level

** indicates significant at 0.01 % level

ns indicates not significant

In general, roots had more evenly distributed in all observed layers under irrigation system when plants had been getting more developed. In rainfed system, root development and its distribution patterns had fluctuated within observed time. The extent of root in the first layer (0-5 cm) had decreased with time, however sharply increased at the last stage. The percentage contributed to respective layer was also fluctuated in rainfed system. The greater root length and density was found in second layer (5-10 cm) in rainfed system (Figure 5). Table17 showed that root density under rainfed system had slowly in creased in the third layer (10-15 cm). The trend of distribution patterns represented as root density at applied nitrogen rate was also differed in both water management systems (Figure 5). In irrigation system, root density at deeper layers had increased more early with greater extent that were received 100 kg N $ha^{-1}$ and 200 kg N $ha^{-1}$ than the others (Table 17). In rainfed system, while the plant which received 100 kg N $ha^{-1}$, had already distributed approximately 60% of root in the second layer at 70 DAS, while the others had lesser percentage contributing to the same soil layer. The maximum root density was recorded at 200 kg N $ha^{-1}$ under irrigation system (0.904 cm $cm^{-3}$) and 100 kg N $ha^{-1}$ under rainfed (0.399 cm $cm^{-3}$) at 100 DAS. However, there was not significant difference between 200 and 100 kg N $ha^{-1}$ application, in LSD comparison.

Table 17: Mean of root length (cm) at different soil layers responded to nitrogen applications under different water management systems.

| Nitrogen rate (kg N ha$^{-1}$) | Soil layer (cm) | Irrigation system | | | | |
|---|---|---|---|---|---|---|
| | | Mean of root length at different soil layer at different stage (DAS) | | | | |
| | | 40 | 55 | 70 | 85 | 100 |
| 0 | 0-5 | 270 | 321 | 290 | 713 | 788 |
| | 5-10 | 373 | 400 | 539 | 1163 | 1382 |
| | 10-15 | 10 | 130 | 333 | 484 | 456 |
| 100 | 0-5 | 241 | 289 | 499 | 1038 | 1535 |
| | 5-10 | 362 | 651 | 1155 | 1521 | 2220 |
| | 10-15 | 1 | 161 | 657 | 1084 | 1430 |
| 200 | 0-5 | 226 | 305 | 506 | 978 | 1601 |
| | 5-10 | 269 | 362 | 899 | 1336 | 2187 |
| | 10-15 | 24 | 105 | 464 | 1028 | 1642 |
| 400 | 0-5 | 168 | 225 | 294 | 466 | 821 |
| | 5-10 | 234 | 283 | 426 | 904 | 1384 |
| | 10-15 | 7 | 56 | 194 | 301 | 625 |

| Nitrogen rate (kg N ha$^{-1}$) | Soil layer (cm) | Rainfed system | | | | |
|---|---|---|---|---|---|---|
| | | Mean of root length at different soil layer at different stage (DAS) | | | | |
| | | 40 | 55 | 70 | 85 | 100 |
| 0 | 0-5 | 258 | 308 | 154 | 176 | 383 |
| | 5-10 | 328 | 344 | 472 | 342 | 801 |
| | 10-15 | 29 | 131 | 161 | 172 | 194 |
| 100 | 0-5 | 194 | 221 | 223 | 232 | 1176 |
| | 5-10 | 239 | 349 | 634 | 445 | 962 |
| | 10-15 | 50 | 174 | 197 | 220 | 260 |
| 200 | 0-5 | 165 | 199 | 208 | 143 | 536 |
| | 5-10 | 185 | 239 | 438 | 305 | 764 |
| | 10-15 | 8 | 100 | 145 | 160 | 243 |
| 400 | 0-5 | 117 | 135 | 170 | 156 | 499 |
| | 5-10 | 180 | 216 | 346 | 288 | 979 |
| | 10-15 | 9 | 73 | 168 | 146 | 181 |

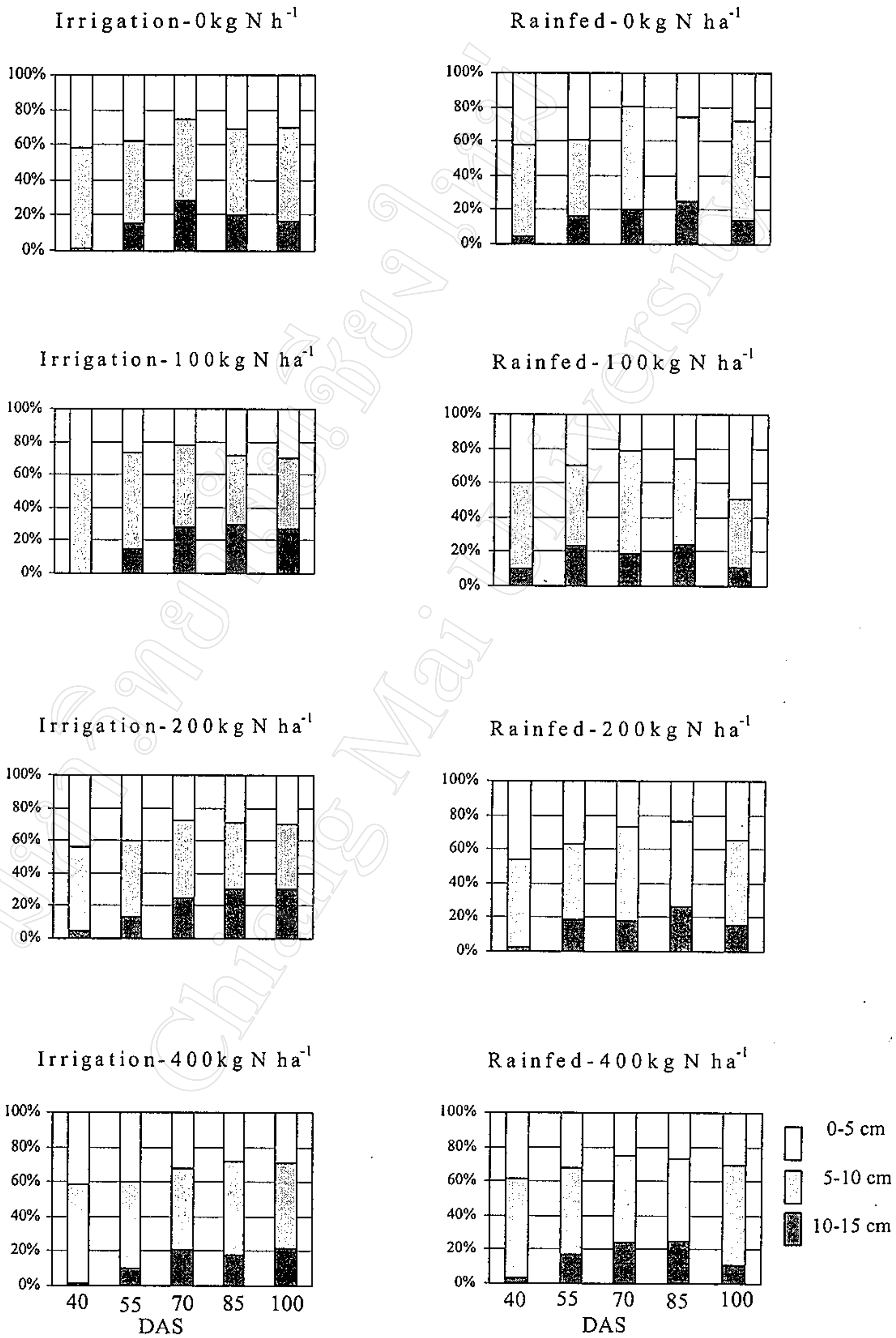



Figure 5: Distribution of root density at different observed soil layers responded to nitrogen rates under different water management systems.

## 5.4. The response of sugarcane above ground parts

### 5.4.1. Dry matter

The results of analysis of variance for the dry weight of above ground parts showed that the dry weight had highly significant responses to applied nitrogen fertilizer (Table 18). Also, there was significant between different water regimes at all stages (*$p<0.05$*). Although the interaction effect was not significant at the beginning (40 and 55 DAS), nitrogen and soil water regimes had strongly interacted at later stages (70 and 85 DAS). The highest dry weight of above ground parts was finally observed at 200 kg N $ha^{-1}$ in irrigation system (92.53 gm $hill^{-1}$) and at 100 kg N $ha^{-1}$ in rainfed system, 11.85 gm $hill^{-1}$ (Figures 6 and 7). In LSD comparison, the maximum above ground dry eight was obtained at 200 kg N $ha^{-1}$, however, there was not significant difference, comparing to the lower level of application.

Table 18: Analysis of variance for dry weight (gm $hill^{-1}$) of above ground plant parts.

| Source of variation | Significant levels at observed stage (DAS) | | | | |
|---|---|---|---|---|---|
| | 40 | 55 | 70 | 85 | 100 |
| Replication (B) | ns | ns | ns | ns | ns |
| Water (W) | * | * | * | * * | * |
| Nitrogen (N) | * * | * * | * * | * * | * * |
| W * N | ns | ns | * * | * * | * * |
| CV% W | 15.71 | 16.17 | 46.55 | 34.13 | 72.99 |
| CV% N | 12.63 | 20.46 | 31.61 | 19.52 | 32.24 |

* indicates significant at 0.05 % level

** indicates significant at 0.01 % level

ns indicates not significant

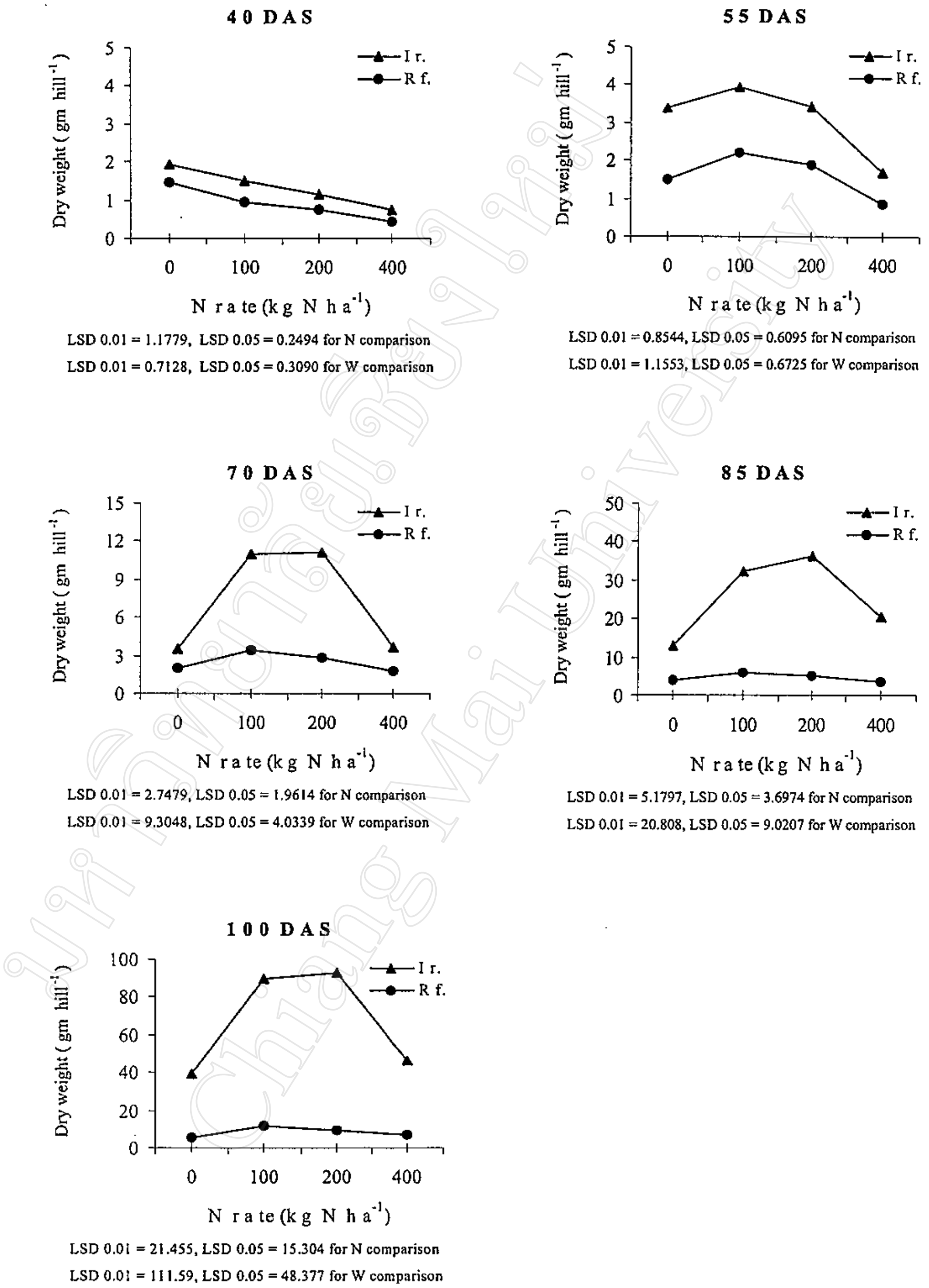



Figure 6: Sugarcane above ground dry weight (gm hill$^{-1}$) response to nitrogen rates at different stages under irrigation system (—▲—) and rainfed system (—●—), where; N refers to nitrogen and W refers to water for LSD comparison.

Sugarcane above ground dry weight had significantly responses to applied nitrogen fertilizer rates under different water regimes, and the accumulation of dry weight of above ground plant parts were quite different between two water management systems. The dry weight of above ground parts of sugarcane decreased with increasing rate of applied nitrogen fertilizer at beginning (40 DAS). At later stages, the response pattern had changed in both water management systems. The dry weight dramatically increased at later stages in irrigation while slowly in rainfed (Figure 7).

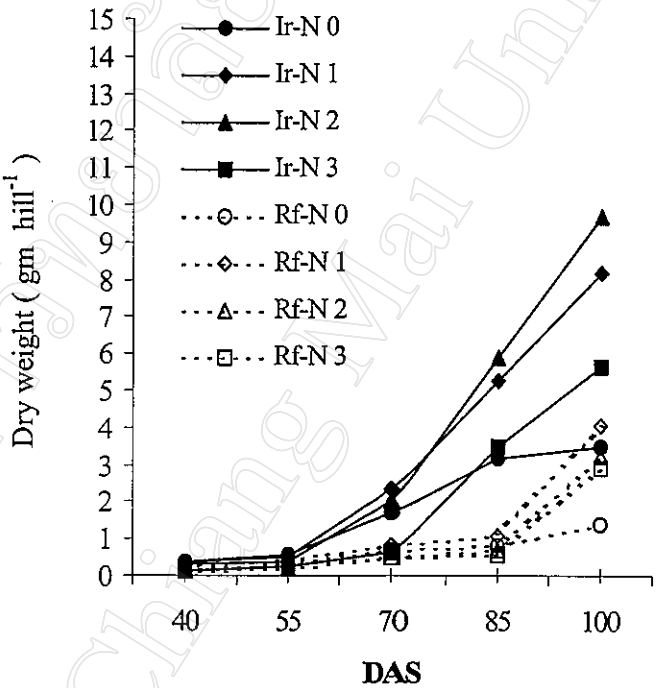



Figure 7: Dry matter accumulation of sugarcane above ground parts over the observation period, at nitrogen applications under irrigation system(—▲—) and rainfed system (—•—), where N0,N1,N2, N3 refers as 0,100,200,400 kg N ha$^{-1}$, respectively.

Generally, the dry weight at all nitrogen application was greater comparing to none application level at the final stage (100 DAS). In LSD comparison, the dry weight at 400 kg N ha$^{-1}$ was significantly differed (*$p<0.05$*) from none application.

### 5.4.2. Leaf area and number of tillers per hill

Leaf area and number of tillers were recorded at 85 DAS and 100 DAS since they are important yield components contributing to fresh sugarcane yield. The number of tiller $hill^{-1}$ referred as mean of three hills per plot. The analysis of variance revealed that both of number of tillers and leaf area had significant response to applied nitrogen rates *($p< 0.01$)*, but also responded to different water management systems *($p< 0.05$)*. Both of them had increased with increasing rate of nitrogen, up to 200 kg N $ha^{-1}$ in irrigated water management system. Although the interaction between nitrogen and water was highly significant in leaf area *($p< 0.01$)* at observed stages, no significance of interaction for mean of number of tillers $hill^{-1}$ at 85 DAS and there was significant at 100 DAS. The maximum number, 15-tiller $hill^{-1}$, was recorded at 200 kg N $ha^{-1}$ under irrigation system.

Table 19: Analysis of variance for number of tiller $hill^{-1}$, and leaf area ($m^2$ $hill^{-1}$) at observed stages.

| Source of variation | Significant levels at observed stages (DAS) | | | |
|---|---|---|---|---|
| | Number of tillers $hill^{-1}$ | | Leaf area ( $m^2$ $hill^{-1}$) | |
| | 85 | 100 | 85 | 100 |
| Replication (B) | ns | ns | ns | ns |
| Water (W) | * | * | * | * |
| Nitrogen (N) | * * | * * | * * | * * |
| W * N | ns | * | * * | * * |
| CV% W | 51.95 | 30.30 | 63.78 | 56.18 |
| CV% N | 20.86 | 16.83 | 29.30 | 26.30 |

* indicates significant at 0.05 % level

** indicates significant at 0.01 % level

ns indicates not significant

As summary, the tillering capacity had being greater with increasing nitrogen rate until 200 kg N $ha^{-1}$. On the contrary, the highest number of tillers was found at 100 kg N $ha^{-1}$ under rainfed. The grater number of tiller per hill at all nitrogen application under both water management systems comparing with none application, in general. However, there was not significant interaction between water status and nitrogen application that effect on tillering capacity at 85 DAS, later, there was significant at 100 DAS. Therefore, tillering capacity was dependent on nitrogen level and water status.

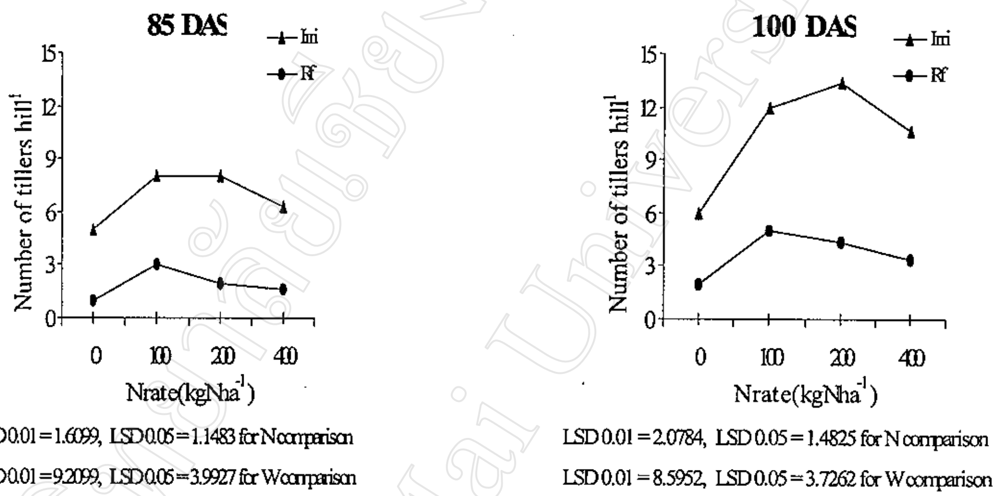



Figure 8: Number of sugarcane tillers hill$^{-1}$ at different nitrogen rates, under irrigation system (—▲—) and rainfed system (—●—), where; N refers to nitrogen and W refers to water for LSD comparison.

Leaf area had increased dramatically and the canopy had entirely closed at 200 kg N ha$^{-1}$ and 100 kg N ha$^{-1}$ with respective spacing (30 cm x 30 cm) within the observed interval, in irrigation system. Although maximum leaf area (9.83 m$^2$ hill$^{-1}$) was recorded at 200 kg N ha$^{-1}$ in irrigation system, 100 kg N ha$^{-1}$ had highest leaf area (0.65 m$^2$ hill$^{-1}$) in rainfed system. The responded result was similar as number of tillers hill$^{-1}$.

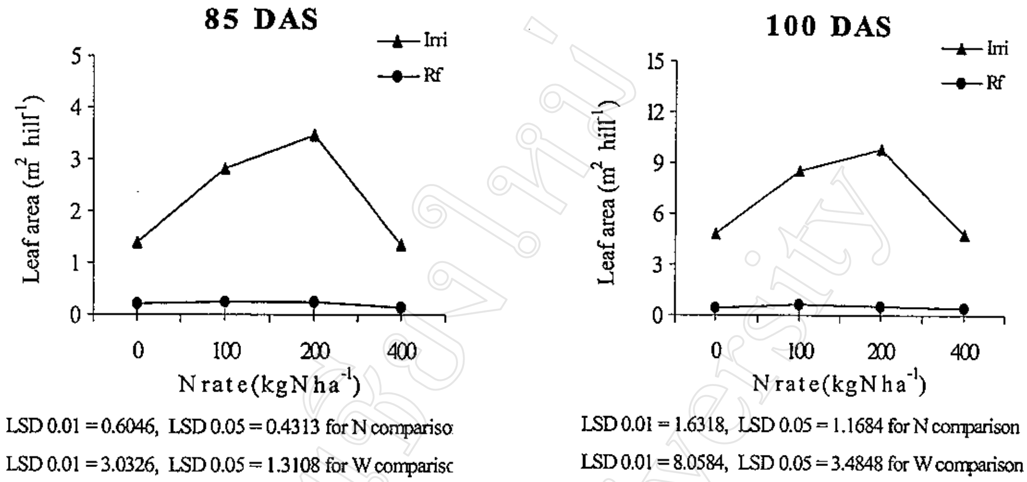



Figure 9: Leaf area (m$^2$ hill$^{-1}$) at different nitrogen rates, under irrigation system (-▲-) and rainfed system (-●- ), where; N refers to nitrogen and W refers to water for LSD comparison

## 5.5. Total Nitrogen content in plant parts

Total nitrogen contents in both of above ground plant parts and roots were determined at all respective stages, in order to examine nitrogen uptake by plants. The above ground plant parts were mixed together and determined to total nitrogen content. The analysis of variance for total nitrogen content in above ground plant parts and root results were showed in Tables 20 and 21. The results from analysis of variance revealed that the nitrogen content in above ground parts was not significant at the beginning (40 and 55 DAS) and high significantly responded to applied nitrogen at later stages (70, 85 and 100 DAS). Generally, the nitrogen content in above ground parts had higher with increased nitrogen application rate (Figures 10 and 11). At 100 DAS, the nitrogen contents at 100 kg N ha$^{-1}$ was significantly higher ($p < 0.05$) than none application in LSD comparison. There were not significant between two water management systems, except 55 DAS. Similarly, the interaction effect of water status and nitrogen was not significant at all stages, except 85 DAS, which was the nitrogen content under rainfed was higher than under irrigation system.

However, it was not significant difference between two water management systems in LSD comparison.

Table 20: The analysis of variance for total nitrogen content (percentage) in sugarcane above ground parts.

| Source of variation | Significant levels at observed stage (DAS) | | | | |
|---|---|---|---|---|---|
| | 40 | 55 | 70 | 85 | 100 |
| Replication (B) | ns | ns | ns | ns | ns |
| Water (W) | ns | * | ns | ns | ns |
| Nitrogen (N) | ns | ns | * * | * * | * * |
| W * N | ns | ns | ns | * | ns |
| CV% W | 65.62 | 14.66 | 29.11 | 27.35 | 11.55 |
| CV% N | 19.68 | 11.38 | 16.42 | 10.80 | 7.86 |

* indicates significant at 0.05 % level
** indicates significant at 0.01 % level
ns indicates not significant

Table 21: The analysis of variance for total nitrogen content (percentage) in sugarcane roots.

| Source of variation | Significant levels at observed stage (DAS) | | | | |
|---|---|---|---|---|---|
| | 40 | 55 | 70 | 85 | 100 |
| Replication (B) | ns | ns | ns | ns | ns |
| Water (W) | ns | ns | ns | ns | * |
| Nitrogen (N) | * * | * * | * * | * * | * * |
| W * N | ns | ns | * | ns | * * |
| CV% W | 25.19 | 19.77 | 31.08 | 23.89 | 28.56 |
| CV% N | 24.38 | 19.98 | 16.85 | 19.98 | 20.71 |

* indicates significant at 0.05 % level
** indicates significant at 0.01 % level
ns indicates not significant

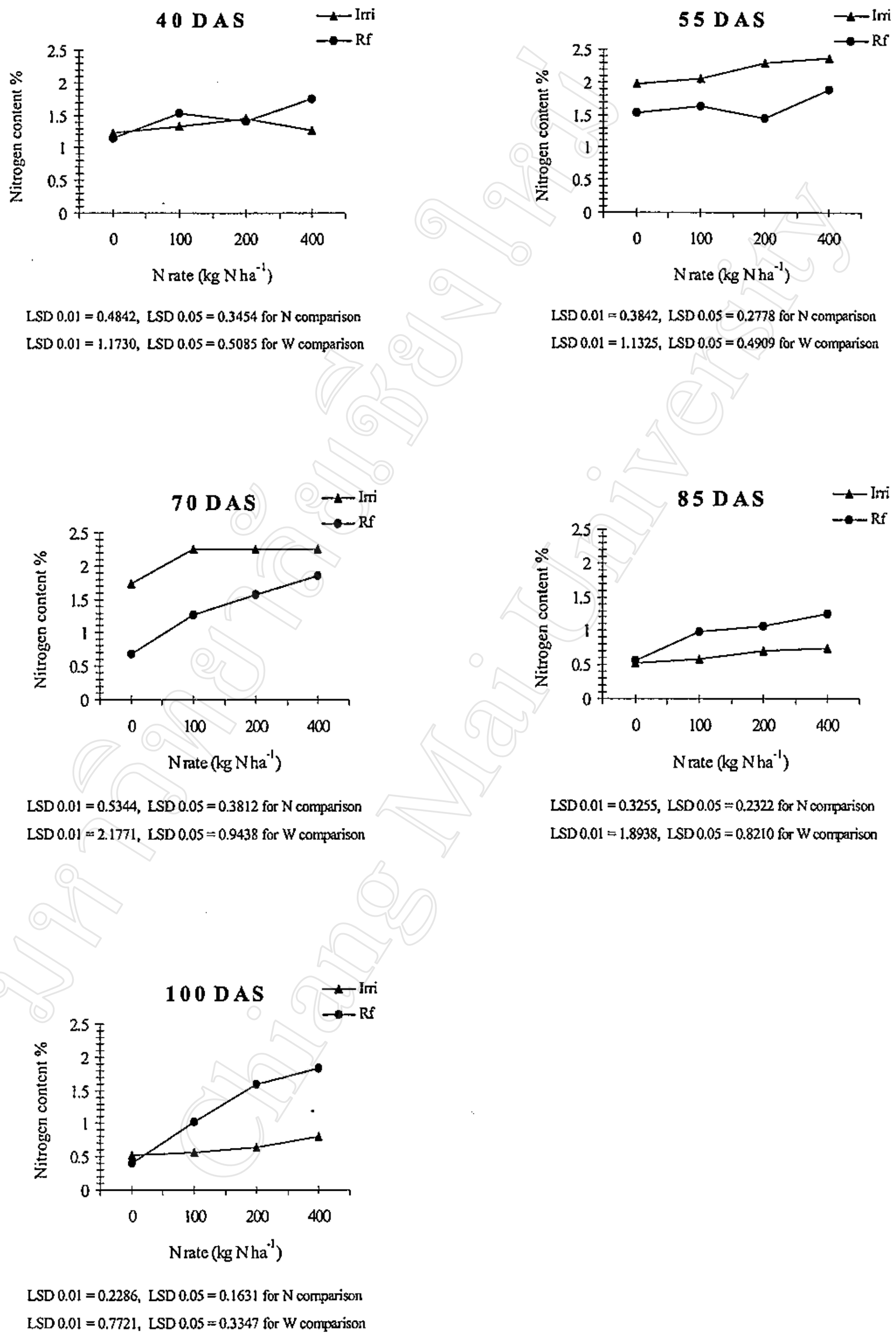



Figure 10: Total nitrogen content in above ground parts at nitrogen application, under irrigation system (-▲-) and rainfed system (-●-), where; N refers to nitrogen and W refers to water for LSD comparison.

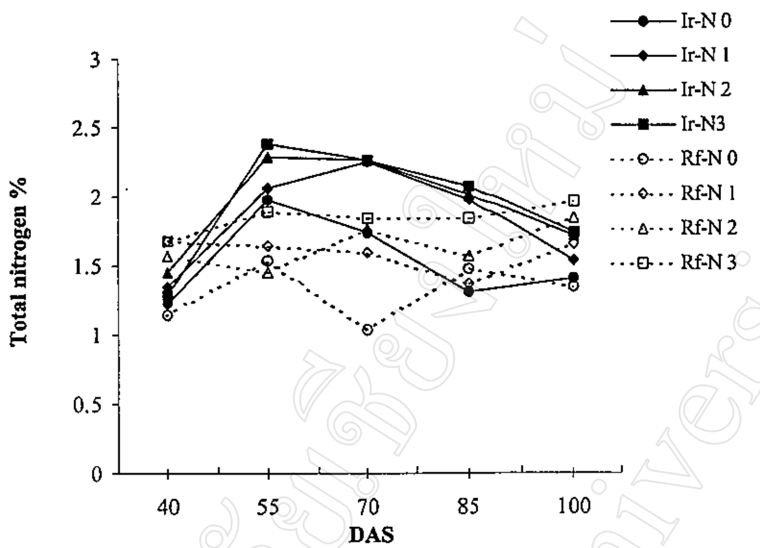



Figure 11: Total nitrogen content in above ground parts over the observation period at different nitrogen application, under irrigation system (-▲-) and rainfed system (-●- ), where; N0,N1,N2, N3 refers as 0,100,200,400 kg N ha$^{-1}$, respectively.

The peak total nitrogen content in sugarcane above ground parts at all nitrogen application was found at 55 DAS in irrigation system. There were two remarkable findings; one was that the nitrogen content in above ground plant parts under rainfed system was higher than irrigation system at 85 DAS and 100 DAS (Figure 10). The another was a significant difference ($p<0.05$) between two water management systems at 55 DAS (Table 20), which the total nitrogen content in the irrigation system was higher than the rainfed system.

The results from analysis of variance indicated that total nitrogen content in root was significantly responded to applied nitrogen at all stages. However, there were not significant among nitrogen applications at 40 DAS. The nitrogen contents at all application were significantly higher than none application at later stages, 70, 85 and 100 DAS. In irrigation system, the peak of total nitrogen content in sugarcane roots was found at 55 DAS, after that declined with time. The high nitrogen contents in root were found at 70 DAS and 100 DAS under rainfed system. The nitrogen content in roots under rainfed system was higher than irrigation system at later stages: 70 DAS, 85 DAS and 100 DAS (Figures 12 and 13), and fluctuated. There was only significant difference ($p<0.05$) between two water management systems was found at 100 DAS (Table 21).

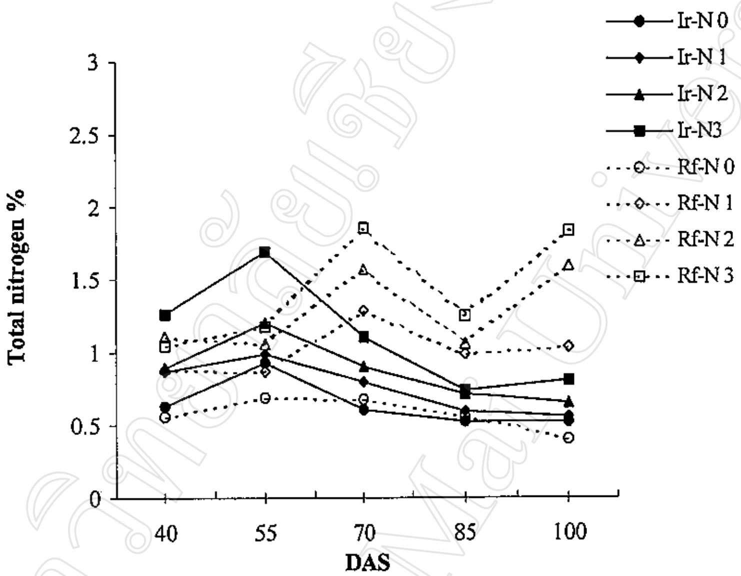



Figure 12: Total nitrogen content in roots over the observation period at different nitrogen application, under irrigation system (-▲-) and rainfed system (-●-), where; N0,N1,N2, N3 refers as 0,100,200,400 kg N $ha^{-1}$, respectively.

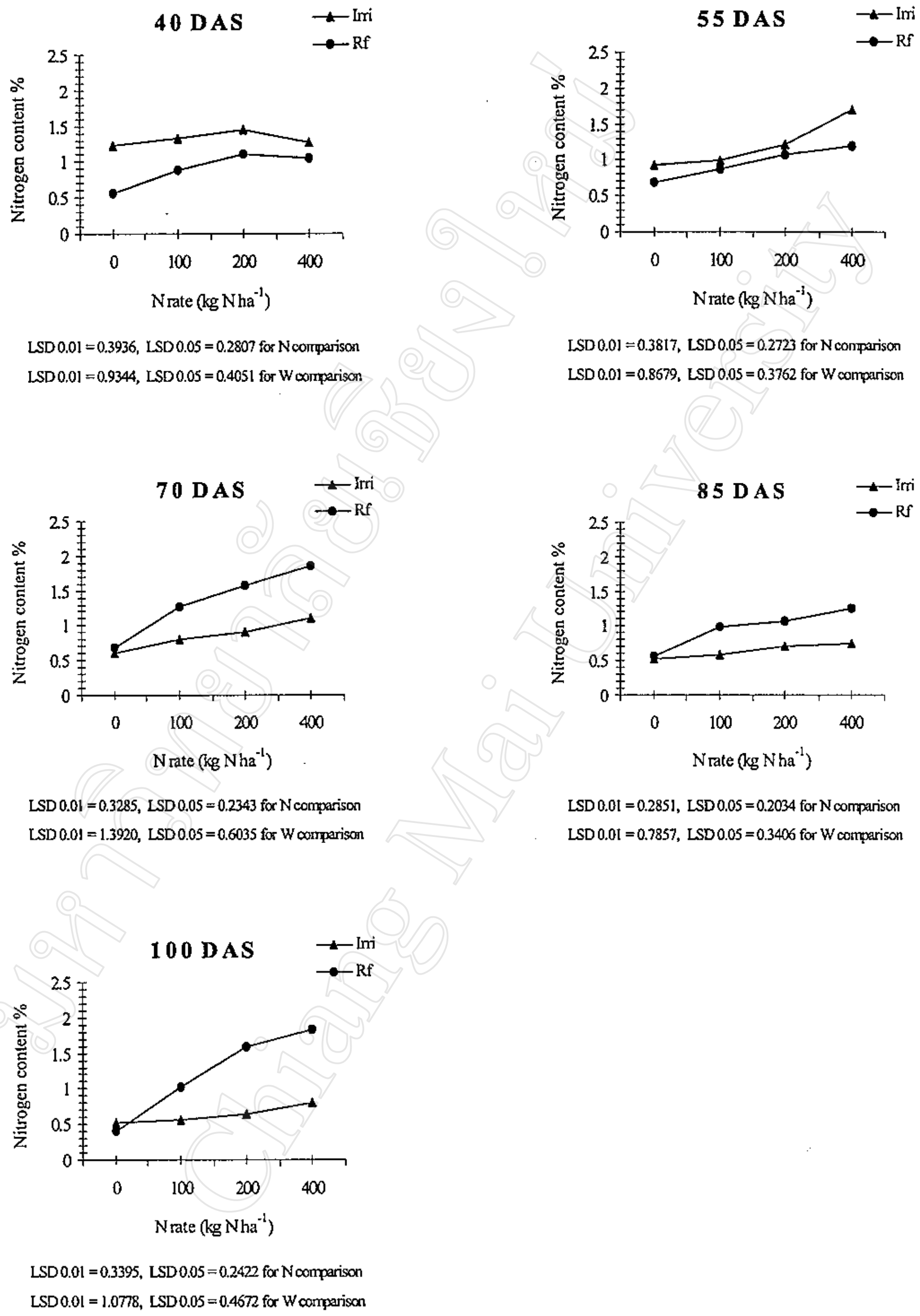



Figure 13: Total nitrogen content in roots at observed stage at nitrogen application, under irrigation system (-▲-) and rainfed system ( -●- ), where; N refers to nitrogen and W refers to water for LSD comparison.

## 5.6. Effect of nitrogen application and irrigation on soil pH and total nitrogen content in soil at observed stage (100 DAS)

The effects of nitrogen application and irrigation on pH and total nitrogen content in soil system were examined at 100 DAS. The results were presented in Table 22. Based on the results of soil tests, analysis of variance resulted that the effect of nitrogen application on soil pH was highly significant. The effect of irrigated water *($p=0.0658$)*, was not significant, however, closed to significant level and interaction between nitrogen and water was not significant. Soil pH was decreased with increased nitrogen application in both water management systems (Figure 14). On the other hand, there was no significance for total nitrogen content in soil among the applications under different water management systems at observed stage (100 DAS). However, in generally, the residual total nitrogen content in soil had higher content with the increasing nitrogen application rate. In addition, residual total N content in rainfed was higher than irrigation at observed stage. Moreover, both of nitrogen contents at the observed stage was still slightly higher than initial stage (average of total nitrogen content was 0.032% of two layers, Table 13).

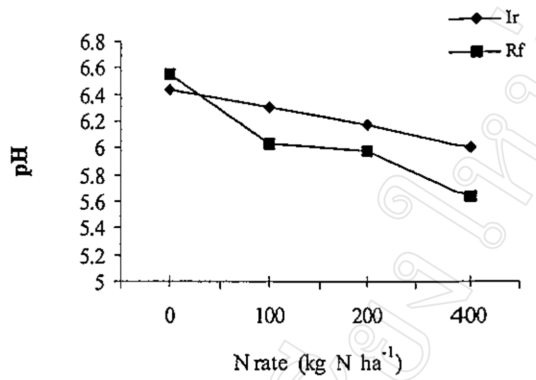
Table 22: The effect of nitrogen application and irrigation on soil pH and total nitrogen content at observed stage (100 DAS).

| Source of variation | Significant levels at observed stage (100 DAS) | |
|---|---|---|
| | pH | Total N content (%) |
| Replication (B) | ns | ns |
| Water (W) | ns | ns |
| Nitrogen (N) | * * | ns |
| W * N | ns | ns |
| CV (%) W | 2.01 | 11.91 |
| CV (%) N | 2.59 | 47.87 |

* indicates significant at 0.05 % level

** indicates significant at 0.01 % level

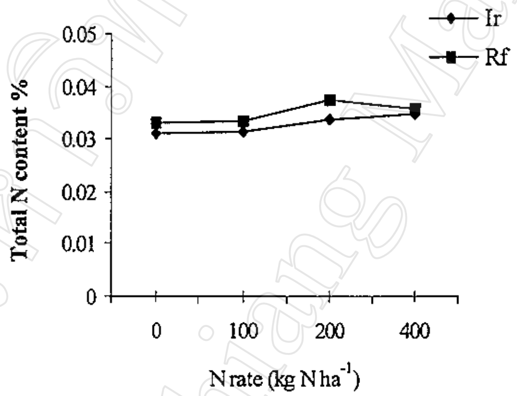
ns indicates not significant




LSD 0.01 = 0.2810, LSD 0.05 = 0.2005 for N comparison

LSD 0.01 = 0.5004, LSD 0.05 = 0.2169 for W comparison

Figure 14: Effect of Nitrogen application on soil pH under irrigation system (-♦-) and rainfed system (-■-), at observed stage (100 DAS).




LSD 0.01 = 0.0090, LSD 0.05 = 0.0064 for N comparison

LSD 0.01 = 0.0001, LSD 0.05 = 0.0071 for W comparison

Figure 15: Total nitrogen content (percentage) in 100 gm soil under irrigation system (-♦-) and rainfed system (-■-), at observed stage (100 DAS).

## 5.7. Efficiencies of nitrogen fertilization

The efficiencies at each nitrogen application rate were calculated in term of agronomic or economic efficiency (using equation 2, Chapter 2) physiological efficiency (using equation 3, Chapter 2) and nutrient use efficiency (using equation 4, Chapter 2). Green biomass weight of above ground parts per hill was used to calculate the agronomic efficiency instead of crop yield. Although the experiment was not conducted in glasshouse, nutrient use efficiency under given environmental circumstances at the field was calculated. The results were presented in Table 23.

Table 23: Efficiencies of nitrogen applications under different water management systems.

| Treatment | Irrigation | | | | Rainfed | | | |
|---|---|---|---|---|---|---|---|---|
| Kg N $ha^{-1}$ | Increase yield % | AE | P E | NUE % | Increase yield % | AE | PE | NUE % |
| 100 | 228 | 16.52 | 0.61 | 26.95 | 275 | 4.02 | 0.55 | 7.32 |
| 200 | 235 | 8.76 | 0.51 | 12.89 | 215 | 1.32 | 0.44 | 2.99 |
| 400 | 118 | 0.59 | 0.28 | 2.12 | 151 | 0.29 | 0.32 | 0.93 |

Note: AE= Agronomic Efficiency, PE= Physiological Efficiency, NUE= Nitrogen Use Efficiency

The biomass yield at all nitrogen applications had greater than none application in both water management systems. The highest biomass yield obtained at 200 kg N $ha^{-1}$ under irrigation system while the highest yield had recorded at 100 kg N $ha^{-1}$ in rainfed system. The highest increased yield percentage (235%) was obtained from 200 kg N ha application in irrigation system while 100 kg N ha application gave the highest in rainfed system. However, as for efficiency, it was found that not only the highest agronomic efficiency but also nutrient use efficiency obtained from 100 kg N $ha^{-1}$ application in both water management systems.