IV. Results and Discussions

A- First study:

Effect of water depths on emergence and growth of *Echinochloa spp.*

A-1- Growth measurements :

A-1-1- Effect of *Echinochloa* species:

According to data recorded in (Table 2), the percentages of emergence were significantly affected the different *Echinochloa spp*. under the study. The, greater differences were observed among the species. Emergence percentage of *E. oryzoides* was higher than the emergence of *E. crus-galli* and *E. Phyllopogon* by 44.15% and 11.26% respectively. Seedlings of *E. phyllopogon* produced higher fresh than the other species. Lower fresh weight was recorded from *E. crus- galli*. *Echinochloa. oryzoides* seedlings recorded the tallest plants followed by *E. phyllopogon*, may be due to their tolerance to submergence. While, seedlings of *E. crus-galli* were the shortest.

A-1-2- Effect of water depth

The percentage of emergence was also significantly reduced sharply with increasing water depths over the soil surface. For example, emergence was reduced by 17.33 and 56.32% respectively, when water regime was changed from saturated condition to 2 and 4cm water depths. It was observed that, increasing water depth to 6cm or more resulted in failure of the seed germination and consequently emergence of their seedlings. **Bayer and Hill (1992)** pointed out that early watergrass (*E. oryzoides*) and late watergrass (*E. phyllopogon*), unlike barnyardgrass (*E. crus-galli*) can emerge through up to 13 cm of water. In addition**, Nishida and Kasahara (1975)** observed that C4 plants, such as *Echinochloa crus-galli* do not survive under submerged

condition. Also, **Hassan *et al* (2002)** reported similar data to the present study.

Fresh weight of *Echinochloa* species seedlings was significantly higher when they were grown under the saturated water regime condition. Increasing water depth reduced fresh weight of weed seedlings. The present study revealed data in agreement with the previously obtained by **Bayer and Hill (1992)** and **Hassan *et al* (2002).**

Seedlings of *Echinochloa* grown under the saturated soil condition or under 2-cm water depth were non-significant in their heights. Increasing water depth to 4-cm produced shorter seedlings (Table 2). The same trend was recorded by **Diop and Moody (1984) and Hassan *et al* (2002)**.

A-1-3- Effect of the interaction between *Echinochloa spp* and water regimes:

Percentage of emergence (15 DAP), fresh weight and plant height of 30 days old seedlings were established in (Table 3). Significant interaction effects between water regime and *Echinochloa* spp. were reported. The saturated soil condition as well as the standing water depth of 2-cm were the best two water regime treatments for *E. crus-gallii* to produce an outstanding emergence rates as mentioned by **Nishida and Kasahara (1975) and Bayer and Hill (1992)** as compared to values of the other water regimes treatments and other *Echinochloa* spp. For example percentage of emergence of *E. crus-gallii* grown under saturated (60%) soil condition was higher by about 23 or 56 as compared to its percentages of emergence at 2 or 4 cm water depth. *Echinochloa oryzoides* or *E. phyllopogon* were produced the highest percentage of emergence but without significant (respectively, 86.3 and 83.8%) when they were grown under the same condition. The percentage of emergence of the three species under the standing water depth of 2-cm were significant, and they were lower compared to the saturated condition.

Echinochloa oryzoides recorded 21 and 29% of emergence than *Echinochloa* phyllopogon and *Echinochloa* crus-galli, respectively at 2cm depth of water condition. Sharp reduction in the percentages of the emergence of the three species were obtained when they were grown under 4-cm water depth. However, *Echinochloa oryzoides* recorded the better emergence. Similar data were reported by **Sparacino *et al*., (2002)**.

The fresh weight of *E. oryzoides* was greater in saturated soil than in the standing water at 2-cm, and it was significantly higher by 35 and 55% than *E. phyllopogon* and *E. crus-galli* respectively. At 2-cm depth of water, *E. phyllopogon* produced more significant fresh weight than others (Table 3). This finding was observed previously by **Hassan *et al* (2002).**

The fresh weight of *E .phyllopogon* grown under standing water depths were significantly greater than the fresh weights of *E. crus-galli* and *E. oryzoides* by 68 and 24%, respectively.

Heights of the three *Echinochloa spp*. at 30 DAP were shown better when they grown under the saturated soil or at 2-cm standing water depth. The highest significant plants saturated condition were recorded from *E. oryzoides* and *E. phyllopogon* and they did not differ from height of *E. oryzoides* grown under 2-cm water depth. Approximately the heights of plants of the three species were not significant at 2 or 4-cm water depths conditions. In general emergence of *E. crus-galli* was less than those of *E. oryzoides* and *E. phyllopogon* at saturated soil, 2cm and 4cm water depth because both species were mentioned as watergrass which they can grow through up to 13 cm water **(Bayer and Hill, 1992**, **and Li (1985)** also mentioned, *E. crus-galli*, as a C4 plant, was biochemically and anatomically adapted for

increased photosynthic activity over rice (C3); submerged culture protected rice plants from severe competition with *E. crus-galli* .

The present study will add to the above, *Echinochloa spp.* are easy to suppress in manually transplanted rice by increasing the water depth as soon as after planting. If flooding was delayed the control of *E. crus-galli* was failed **(Smith *et al* 1977).** Herbicide use was reduced to 50% when higher seeding rate was integrated with continuous flooding in broadcast seeded rice **(Hassan and Mahrous, 1989)** or only when continuous flooding was done for 2-3 weeks in manually transplanted rice **(Hassan and Abou EL-Darag, 2000).** Means for the interaction between B x D x S were found herein to be significant for fresh weight (g)/plot. This finding revealed that this trait responded to effect of B x D differently from season to another.

B- Second study:

Effect of planting date on growth and yield components of *Echinochloa spp*.

B-1- Growth measurements :

B-1-1 - Effect of planting date:

Emergence of the first, second and third leaf of *Echinochloa* seedling was, highly significantly affected by the planting date during the two seasons (Table 4). The rapid emergence of the first leaf was observed in 1st of July planting date (5.2 days), while it was slowly (7.3-7.5 days) at the planting date of May 20th or June 10th . Also, emergence of the second leaf and the third leaf of *Echinochloa* were observed in the earlier seedling at 8.6 and 9.8 days, respectively when planting done on July 1st. Delayed emergences of the second leaf (9.8 to 10.1 days) or third leaf (13.8 days) were reported for the earlier planting date 20th of May. **Kwon *et al* (1996)** found that percentage

emergence of barnyardgrass increased almost linearly with temperature up to 30 ^{0}C. This information was confirmed the emergence of the weed seedlings early and consequently its foliage emergence with increasing temperature at July.

The production of the first tiller in *Echinochloa* plants was achieved in only 16 days when the seeds were planted in June 1st, while planting before or after this time increased periods of the first tiller production (Table 4). Longer periods of 19.8 and 20.2 days for producing the first tiller were recorded with June 20th and May 20th planting dates. Time needed for the emergence of the second tiller was ranged between 1.7 days to 3.7 days from the emergence of the first tiller depending on the date of planting (Table 4). Planting date of June 1st exhibited earlier production of the first and second tiller. Not withstanding the period between the production of the first and the second tiller was 3.2 days. While, this period was reduced to 1.7 days when the planting date was June 1st. Production of the first and second tiller took longer period when the planting date was in June 20th . Also, a longer period (3.7 days) was recorded between the first and second tiller. Planting date of June 20th was continued to produce the third tiller in *Echinochloa* in a longer period of 27.5 days. While, date of planting in June 1st was continued to produced the third tiller in a shorter period of 23 days. However, the delayed planting date up to July 1st also exhibited shorter period (22.6 days) in producing plants at 3-tillers stage (Table 4).

Identifying heading date of the three *Echinochloa* species is an important information needed in appropriate weed control strategy depend on suppressing weed seed bank. Heading date of *Echinochloa* species almost affected significantly by planting date, (Table 4). Plants were headed after 90.5 days when planting was done of May 10th. Heading date was occurred after 95.3 days when planting was done of May 20th. Delayed planting time after May 20th resulted in reduction in time required to achieve heading.

Consequently, heading date was occurred in *Echinochloa* plant after a short period of 73.3 days when planting was accomplished of July 1st. These results were in agreement with **Norris (1996)** on barnyardgrass. *E. crus-galli* plants were headed earliest (after 82.9 days), followed by *E. oryzoides* plants (after 86.3 days). The late heading (after 87.7 days) was observed in *E. phyllopogon* plants. The heading of *E. crus-galli* and *E. phyllopogon* in this study were earlier than that mentioned by **Bayer and Hill (1992).**

The highest plant of *Echinochloa* was resulted from the early planting date of May 10th. Delaying planting date pronounced significant gradual reduction in height of weed plants. Delayed planting date up to July 1st resulted in significant reduction in height of weed plants by 61.7 cm as compared to the planting in May 10th. **Norris (1996)** found that longest tiller length per plant of *E. crus-galli* averaged 150 cm and did not differ by planting date, while **Keeley and Thullen (1989)** found that planting of *E. crus-galli* in June produced the tallest plants. Weed density and time of emergence of the weed relative to the crop are two of the most critical factors affecting weed interference **(Joenje and Kropff, 1987 and Berkowitz, 1988)**.So, the present study investigate the different periods spend for the emergence of *Echinachloa spp* leaves which may affected the magnitude rice yield reductions. Moreover, different times or prolonged period of emergence of the weed leaves will determine the critical times of control measures **(Hassan, 2002).**

B-1-2- Effect of *Echinochloa* species:

Among the three species of *Echinochloa*, both of *E. oryzoides* and *E. phyllopogon*, emergence of each of the three leaves were earlier than in *E. crus-galli*. For example, emergence of the first leaf in *E. curs-galli* was observed at 1.3 to 1.1 days later than in the other two species.

Likewise for the emergence of the second leaf which take one day more as compare with the other two species while, the emergence of the third leaf was taken 1.2 or 1.5 days more as compared to the emergence of the third leaf in *E. Phylopogon* or *E. oryzoides*. **Keeley and Thulien (1989)** confirmed this data in similar study on *E. colona*. **Chun and Moody (1986)** found that it reached two leaves stage at 8 DAS. While **Azmi et al., (1995)** found that in Malaysia *E. curs-galli* produced the first three leaves in three to four days after planting. The production of the first, second, or third tiller has been taken longer period in *E. crus-galli* specie than *E. oryzoides* or *E. phyllopogon* (Table 4). He found that *E. curs-galli* started producing tillers at 14-16 days after emergence. The work of **Norris (1996)** on barnyardgrass indicated that the number of tillers declined with planting date in mid-August and mid-September. Both works may confirmed the results of the present study.

The results in Table 4. showed that no significant differences in heights of the *Echinochloa spp* .were recorded. Whereas *E. phyllopogon* had the longer heading date compared with another species.

B-1-3- Effect of the interaction between *Echinochloa species* and planting date.

According to data obtained in Table (5) the establishment of the second tiller was achieved in 24.5 and 25 days for *E. curs-galli* when the seeds were planted in May 20th and June 20th, respectively. Shorter period of 19.5 days exhibited the second tiller in *E. crus-galli* when the seeds were planted in June 1st. Similar results were obtained by **Norris (1996) and Chun and Moody (1986)** on *E. colona*. The emergence of the second tiller in *E. oryzoides* was recorded in shortest time at 19 or 19.5 days when seeds were planted in May 10th or June 1st. while the longest times exhibited the second tiller were 22 or 22.5 days when seeds were sown in May 20th or June 20th

with no significant between them. The shortest period exhibited the second tiller of *E. phyllopogon* was 18.5 days when seeds were sown in May 10th or June 1st. followed by July 1st (19 days). While delayed sowing in June 20th produced the second tiller in longer period (23 days). It was appeared that sowing date of May 10th enhanced the development of both *E. oryzoides* and *phyllopogon*. **Keeley and Thullen (1989)** reported that increasing day length favored vegetative growth of barnyardgrass, consequently in this study, maximum time for establishment of the third tiller in *E. crus-galli* was 28.5 days, which occurred in planting time in June 20th. It reached 27.5 days in *E. phyllopogon* with no significant between them. While, 26.5 days period was the maximum for *E. oryzoides* which resulted from the planting date in May 20th . The third tiller was formed after a short of 22.5 or 23.5 days in *E. crus-galli* when it planted in May 10th or June 1st and July 1st. The lowest significant period for development of the third tiller were 20 and 20.5 days, respectively for *E. phyllopogon* and *E. oryzoides* at planting date of May 20th Longest time for development of the third tiller of *E. oryzoides* was 26.5 days with planting date in May 20th or June 20th. While this time was 27.5 days with *E. phyllopogon* at planting in June 20th (Table 5). These data as well as data reported by **Kwon *et al*. (1996)** indicated to the rapid emergence and seedling establishment of *Echinochloa spp* earlier than rice plant which sometimes makes control become more difficult in direct-seeded rice **(Hassan, 2002).**

The results recorded in Table (5) on heading date expressed significant interaction effects between planting date and *Echinochloa spp*. Delaying planting in July 1st caused significant earlier heading in the three species of *Echinochloa*. The earliest heading plants were observed in *E. oryzoides* (72.5 days) followed by *E. phyllopogon* (73.5 days) and *E. crus-galli* (74.0 days). Planting seeds of *Echinochloa* in May 20th caused the latest heading for the three species.

For example heading of *E. crus-galli, E. oryzoides* and *E. phyllopogon* were achieved in 92, 95 and 96 days, respectively, when planting date was May 20th. Delayed planting after May 20th resulted in significant reduction in periods to achieve heading in the three species of *Echinochloa*.

The tallest plants were found in *E. crus-galli* species with May 10th planting date (162.6-cm) almost more than reported by **Norris (1996).** Also, planting date in May 10th of *E. oryzoides* produced non significant plant heights (158.6 cm) as compared to May 10th planting date (151.3 cm) of *E. phyllopogon.* Heights of plants were greatly reduced with delayed the planting date of the three species of *Echinochloa*. The shortest plants of *Echinochloa spp* were resulted in the latest planting date in July 1st with no significant differences among the three species (Table 5).

B- 2- Yield components :

B-2-1. Effect of planting date:

The results of the number of filled grains /panicle of *Echinochloa spp*. (Table 6) indicate that maximum of filled grains of *Echinochloa spp.* panicles was 606, produced from planting date in May 10th. Reduction in number of filled grains/panicle was increased with delaying planting from May 10th to July 1st. Filled grains/panicles were reduced by 37.9 % due to late planting in July 1st.These results were confirmed by **Norris (1996).** It seems that early planting date in May 10th produced the heavyset weight of panicles (Table 6). Panicle weight was reduced greatly with descend planting date in July 1st.The difference between weight of individual panicle produced from planting date in May 10th and latest planting date in July 1st was 0.83 gm. Insignificant differences were observed in 1000 kernels weight of plants resulted from the all planting dates (Table 6).

Panicle length of May 20th, June 1st, June,20th and July 1st were not differ significantly (Table 6). Shortest panicles were observed in June 10th

planting date. However, it was not significantly differ from panicle length of plants of July 1st planting date. Similar panicle length of the three *Echinochloa spp*. were observed (Table 6)**.** As it is evident, early planting date in May 10th resulted in weed plants with the tallest significant panicles.

B-2-2- Effect of *Echinochloa* species:

Echinochloa crus-galli plants produced greatest number of filled grains/panicle (601.8) as compared to *E. oryzoides* (405.2) or *E. phyllopogon* (377.6). The panicle weight of *E. crus-galli* was heaviest among *Echinochloa* species. But *E. crus-galli* had the lowest weight of 1000-kernel among *Echinochloa* species. The results in Table 6, showed that no significant differences in panicle length of the *Echinochloa spp* .were recorded .

B-2-3- Effect of interaction between *Echinochloa spp* and planting date:

The results of the combined analysis over both seasons on number of filled grains per panicle are presented in Table 7. Early planting of *E crus-galli* in May 10th resulted in the highest filled grains per panicle (796.9). Also, compared to all planting dates, in May 10th was correlated with higher number of filled grains per panicle in the other two species. The lowest number of filled grains per panicle for the all three species, were resulted from the delayed planting date in June 20th and July 1st. The late planting date in July 1st produced 435.4, 372.3 and 321.4 filled grains per panicle, respectively in *E. crus-galli*, *E. oryzoides* and *E. phyllopogon* with insignificant between *E. crus-galli* and *E. oryzoides* or between *E. oryzoides* and *E. phyllopogon*. Planting of *E. crus-galli* seeds in May 20th and June 1st demonstrated better significant filled grains per panicle (694.6 and 672.1) as compared to earlier planting dates of the other species of *Echinochloa*. **Norris (1996)** indicated that the number of inflorescences of *E. crus-galli* was decreased from 4500 per plant to less than 100 with increasing delay in cohort initiation.

Low weight of panicles approximately appeared in *E. phyllopogon* followed by *E. oryzoides*. At the same planting date, weight of panicle of *E. crus-galli* was significantly higher as compared with the other two species. Early planting date of *E. crus-galli* in May 10th resulted in the heaviest weight of panicle in the study (2.30 gm) and significantly followed by *E. phyllopogon* (2.01 g) and *E. oryzoides* (1.68 g) (Table 7). This results was confirmed by **Keeley and Thullen (1989)** on *E. crus-galli*.

C- Third Study:

Intraspecific competition of different *Echinochloa* species as influenced by plant spacing.

C-1- Growth measurements:

C-1-1 Effect of *Echinochloa* species:

The productions of tillers (per hill) of the three species of *Echinochloa* were almost similar (Table 8) when they measured either at 40 DAP (16.7-17.1) or at 60 DAT (27.3-28.5). it means that there was no significant among them in No. of tillers at 40 and 60 DAP.

Dry weight of *E. crus-galli* at 30 DAP was significantly higher (29.2 g/hill) than the dry weight of *E. oryzoides* (21.6 g/hill). While, dry weight of *E. Phyllopogon* (25.1 g/hill) was not significant as compared to the other two species (Table 8). Increasing time of estimation to 45 or 60 DAP resulted in non-significant dry weight per hill among the three species of *Echinchloa*.

Plant height of the three species of *Echinochloa* were non-significant when they assessed at any growth stages started from 45 DAP to harvest time (Table 8).

The results collected on heading date (Table 8) indicated that, *E. crus-galli* headed earlier (88.8 days) than *E.oryzoides* (89.7 days) or *E.phyllopogon* (90.4 days).

C-1-2- Effect of plant density of *Echinochloa* species:

The most significant differences in *Echinochloa spp* production of tillers were recorded as a direct effect of plant density (according to the spacing). For example, at 40 DAP the maximum tillers per hill (22.1) was observed in the widest spacing of 50x50 cm. The tillering capacity was significantly reduced gradually with reducing plant spacing. The minimum number of tillers per hill (11.4) was produced in the narrow-west spacing of 10 x 10 cm (Table 8). These results strongly indicated that the intraspecific competition of *Echinoloa* plants, which started early in the higher density plots. Count of tillers in each hill of *Echinochloa* plants at 60 DAP recorded a measurable differences between the widest spacing of 50 x 50 cm, which resulted in highest (36.5) production of tillers followed by 40 x 40 cm spacing (30.8). While, reducing the spacing from 30 x 30 cm to 10 x 10 cm resulted insignificant and lower tillers per hill. These due to intraspecific competition of *Echinochloa* plants with increasing their density. For example, the reduction in tillering production at 40 DAP in the highest density plots (10x10 cm) was 48%. This reduction was reached to 32% at 60 DAP, indicted to the reduction in intraspecific competition between *Echinochloa* plant at the maximum tillering stage of the weed. **Baki *et al* (1995)** found that the effects of density of barnyardgrass on the number of tillers/plant varied from positive to negative reflecting the unequal influence of density dependent factors on such parameters. For example, **Vail and Oliver (1993)** found that intraspecific competition of *E. crus-galli* increased as its density increased. Also, it was become less competitive as density increased.

The superior dry weight of *Echinochloa* plants at 30 DAP was observed in lower plant density (50 x50, 40 x 40 and 30 x 40 cm) due to the negligible intraspecific competition effects between *Echinochloa* plants (Table 8) and/or as density dependent as mentioned by **Vail and Oliver (1993); Baki *et al* (1995) and Hassan (1996 b).** The dry weight of the weed were significantly

lower at the narrow spacing of 10 x 10 and 20 x 20 cm probably due to the satisfactory effects of the intraspecific competition (43 %). At 45 DAT, the data indicate to 40.6 % reduction in the dry weight per hill of *Echinochloa* plants due to the effects of intraspecific competition of the weed plant when the spacing between hills was changed from 50x50 cm to 10 x 10 cm. The respective reduction effect was 45.3 % at 60 DAP. These results recorded the population effects of the weed plants. The results indicated also to the outstanding production of dry weight per plant or hill escaped from effect of the neighbor plant at optimum density of 30 x 40 cm spacing, which encounter the ideal special interference. Nevertheless, the lower significant dry weight of 50 x 50 cm mainly due to the lower population of the weed.

Also, it was clear to indicate that the narrow row spacing resulted in lower tillering as well as taller plant (Table 8). This may be due to the competition for light. The shorter plants of *Echinochloa* were recorded in row spacing of 50 x 50 cm when measured at 45 DAT or 60 DAT. While, at harvest time, shorter weed plants were obtained in 30 x 30 and 30 x 40 cm row spacing. This infrequent data may be strongly correlated with increasing the production in dry weights (Table 8) of the optimum plant population with minimum spatial interference.

Heading date of *Echinochloa spp* was depending on plant population (row spacing). For example plants grown in closer spacing (88.1-88.9 days) were headed earlier than plants grown in wider spacing (91.2-91.8 days). This finding may be as a direct effect of to the strong spatial intraspecific competition of *Echinochloa* plants. It is appeared that *Echinochloa* species were taken longer time to head in Egypt than in California **(Fischer *et al.*, 2000).**

C-1-3- Effect of the interaction between *Echinochloa* species and plant density:

Table (9) is focusing on the significant variance in dry weight (g/hill) of the three species of *Echinochloa* according to their different populations. The mean dry weight of *E. crus-galli* (44.70 g/hill) and *E. phyllopogon* (45.19 g/hill) were better than the mean dry weight of *E. oryzoides* (45.39 g/hill). The dry weight production of *E. crus-galli* plants were superior at 40 x 40 cm followed by 50 x 50 and 30 x 40 cm. The special intraspecific competition of high populations of these species at 10 x 10 cm resulted in 42 % reduction in the dry weight as compared to the minimum special interference effect occurred with *E. oryzoides* was 39% indicating to the strong intraspecific competition among *E. crus-galli* compared the *E. oryzoides*. The superior dry weight production in *E. phyllopogon* resulted in row spacing of 30 x 40 followed by 20 x 30 and 40 x 40 cm without non-significant differences among them. A greater reduction in dry weight of *E. phyllopogon* (48 %) was recorded in the highest weed population from row spacing of 10 x 10 cm as compared to the maximum production recorded in row spacing 30 x 40 cm. This result was important in illustrating the reason of this weed can overreach the special interference occurred in a better population grown at 30 x 40 cm row spacing. While, the lower weight of *E. phyllopogon* population grown at 50 x 50 cm was mainly due to the survival lower population of the weed. The special intraspecific competition effects of the three species of *Echinochloa* were almost similar when they grown with the highest population (10 x 10 cm). While, this reduction effect was lower with *E. phyllopogon* when it grown at 10 x 10 cm as compared to the other two species. Approximately similar results were obtained with 20 x 20 cm row spacing. In general, all these growth parameters of *Echinochloa spp* were mainly due to the density dependent, which is reflected the degree of interspecific competition **(Hassan, 1996 b) and Baki *et al* (1995).**

Plant height recorded in Table (9) pointed out that the highest of the three species of *Echinochloa* were increased at the high intraspecific competition density (at 10 x 10 cm row spacing) may be due to the competition for light and decreased gradually with reducing plant density. For example, the plant height of *E. crus*-galli, *E. oryzoides* and *E. phyllopogon* grown at narrow spacing of 10 x 10 cm were, 141.3, 128.9 and 133.3 cm, respectively. While the respective height at 50 x 50 cm were, 106.6, 106.5 and 106 cm. The reduction among *E. crus-galli* was in descending order. While, it was infrequent in the other two species. For example heights of the other two species at 30 x 30 cm became shorter than the plants grown at 30 x 40 cm (Table 9). It is appeared that *Echinochloa* plant significantly increased its height in response to shade or lower light transmission to maintained their capacity for high photosynthesis **(Fisher *et al* 2000).** Also**, Yamasue *et al* (1997)** found that the weed adjusted height from 115 cm to 150 cm in response to the height of neighbor plants. However, **Azmi and Itoh (1991)** reported that seed size and weight of *E. oryzicola* were bigger and heavier than *E. curs-galli.*

C-2- Yield components:

C-2-1- Effect of *Echinochloa* species:

E. crus-galli exhibited longer panicle length than the other two species. The three species of *Echinochloa* produced non-significant panicle weight as well as the weight of 1000 kernel (Table 10). The production of panicles of *Echinochloa spp* was considered as better indicator assisting the degree of the intraspecific competition (Table 10). *E. crus-galli* plants exhibited the maximum number of panicles per hill as compared to the two other species. Likewise, the data on number of filled grains per panicle. Also no significant difference was obtained between Sp2 and Sp3 in number of panicles / hill and number of filled grains/ panicle . These differences in yield components of the three species of *Echinochloa* may be due to genetic difference.

C-2-2- Effect of plant density of *Echinochloa* species:

Panicle length of *Echinochloa spp* plants was significantly affected by the plant population. Longer panicle lengths were recorded in plots grown at 20 x 30cm up to 50 x 50 cm. Inferior panicle length was recorded in plots with high population condition planted at 10 x 10 to 20 x 20 cm (Table 10).

Panicle weight of *Echinochloa* species plants were non-significant (from 1.31 up to 1.58 g) the weight of 1000 kernel of *Echinochloa* plants were superior in plants grown at 20 x 20 cm up to 50x50 cm. Reducing plant spacing to 10 x 10 cm up to 20 x 20 cm resulted in lower weight of 1000-kernel (Table 10). The production of panicles per hill of *Echinochloa species* was reached the maximum in plants grown with lower special interference at 50 x 50 cm row spacing. It was reduced gradually and significant with increasing interference effect occurred under the narrow spacing condition. For example, panicle production was reduced 50% as a results for changed the spacing from 50 x 50 cm to 10 x 10 cm. Similar results were reported by **Vail and Oliver (1993)**. Highest number of filled grains per panicle were demonstrated in *Echinochloa spp* plots transplanted at 20 x 30 cm (636) followed by 30 x 40 cm (606.8). The field grains per panicle of plants transplanted at 20 x 20 cm or 50 x 50 cm were non-significant, meanwhile, they were better than the fill grain of panicles of plant spacing of 10 x 10, 10 x 20, 30 x 30 and 40 x 40 cm.

C-2-3- Effect of the interaction between *Echinochloa* species and plant density:

The number of filled grains per panicle of *E. crus-galli* planted at 20 x 30 cm and 30 x 40 cm were highest significant (Table 11). However, the narrow spacing of 10 x 10 cm exhibited better number of fill grains as compared to the rest of plant density of *E. crus-galli*.

The lowest number of filled grains per panicle were recorded in 20 x 20 cm row spacing. However, it was not significantly differ from the values of row spacing of 10 x 20 and 30 x 30 cm. As for *E. oryzoides* the row spacing of 20 x 20 cm exhibited the best value of filled grains per panicles as the value of *E. crus-galli*. The values of high plant population of 10 x 10 cm and low population of 40 x 40 cm row spacing were the lowest and not significant. However, the lowest population of 50 x 50 cm produced better filled grains per panicle. The production of filled grains per panicle of *E. phyllopogon* was superior at 20 x 20 cm row spacing but not as the superior production of filled grains per panicle of the other two species (Table 11). The inferior value of filled grains per panicle of *E. phyllopogon* was resulted in narrow spacing plots of 10 x 10 cm due to the high intraspecific competition (Table 11).

In the same plots planted with the same spacing, *E. crus-galli*, approximately exhibited a greater filled grains per panicle as compared to the other two species. Also, *E. oryzoides* produced more filled grains per panicle than *E. phyllopogon* when they compared at the plant spacing. These data were confirmed by **Baki *et al* (1995).**

D - Fourth Study:

Interspecific competition between rice and different species of *Echinochloa* as influenced by duration of competition and nitrogen levels.

D-1- Growth measurements :

D-1-1- Effects of *Echinochloa* species:

The effect of duration of competition of *Echinochloa spp*. and nitrogen levels on No. of tillers/hill at harvest and dry weight / hill at complete

flowering of rice plants are presented in table (12).. Estimation of the tillering capacity of rice plants at harvest due to the competition effects of the three *Echinochloa spp* exhibited no significant differences in their effects (Table 12). Growth of *E. oryzoides* with rice plants cause more reduction in rice dry weight at flowering stage than the other two species of *Echinochloa* which they cause approximately similar effects (Table 12).

D-1-2. Effect of nitrogen levels:

The production capacity of rice tillers at harvest stage was significantly depending on the rate of application of nitrogen fertilizer. Production of tillers was significantly increased with increasing nitrogen rate from 30 to 90kg/ha with a similar trends at the three stages. Dry weight of rice plants were responded to the increasing of nitrogen fertilizer up to 90 kg N/ha (Table 12).

D-1-3- Effect of duration of competition of *Echinochloa* species:

The production of rice tillers were significantly highest at harvest of growth in rice plots grown free from *Echinochloa spp* all the season or when the weed plants were competed only for 20 days from transplanting and then they were removed completely and kept free to the end of the season. Increasing duration periods of competition behind 20 DAT pronounced a significant reduction effects on production of rice tillers at harvest stage of rice growth. The greatest significant reductions in tillering production were observed in rice plots grown with *Echinochloa* plots for the prolonged period of 60 days or all the season.

Almost rice responded to increased competition through reducing tillering. Many others were indicated to the same results **Noda, (1973); Ampong-Nyarko and De Datta (1992); Rao and Moody (1992); Lakshman *et al* (1999), Salah-ud-din (1994), Hassan (1996a) and Shebl, (2003).**

The severity of *Echinochloa spp.* on dry weight of rice plants is depending on the period of competition. For example, dry weight of rice plants were reduced by 30 and 35% when the weed plants were competed with rice plants for the period of 60 DAT and all season, respectively compared to weed free treatment. The short competition period of 20 days has no suppression effects on dry weight of rice plants when the plants grown free from *Echinochloa* after this period (Table 12). These results were in agreement with the previously obtained by **Ampong-Nyarko and De Datta (1992); Hassan and Rao (1994b); Baki *et al* (1995); Hassan (1996b); Shebl (2003).**

D-1-4- Effect of the interaction between *Echinochloa* species and nitrogen levels:

The present study showed that, the number of rice tillers per hill at harvest growth stages have been shown to vary significantly due to the competitive ability of the different species of *Echinochloa* and the response to different rates of nitrogen application (Table 13). When rice received 1/3 of the rate of nitrogen (at 20 DAT), numbers of tillers per hill were significantly higher compared to non-fertilizered rice plants under presence of *E. oryzoides* or *E. crus-galli* with rice. While, rice plant was grown with *E. phyllopogon*, the first split of nitrogen application did not improve number of rice tillers significantly as compared with non-fertilizered rice.

Number of rice tillers per hill at harvest, under each species of *Echinochloa*, number of rice tillers was significantly lower with the non-fertilized plants and the increasing of tillers was attendance to the increasing of nitrogen application. The highest tillers were recorded in rice plants grown with *E. crus-galli* (16.43) and *E. phyllopogon* (16.03) when plants were received 60kg N/ha. However, no significant differences between number of tillers in plants received 60 or 90 kg N/ha when they grown with *E. oryzoides*

or *E. phyllopogon*, may be due to rice plants were compensate from the weed effects (Table 13). **Shebl (2003)** found that high nitrogen level (120kg N/ha) was necessary to increase number of tillers when it competed with barnyardgrass.

Dry weight of rice plants at complete flowering stage was increased significantly with increasing nitrogen application rate in plots containing rice and weed plants (Table 13). The highest values of rice dry weights were recorded when rice competed with *E. phyllopogon* and all plants received 90kg N./ha because the crop was relatively benefited from more nitrogen **(Ampong-Nyarko and De-Datta, (1992).** Competitive effects of *E. oryzoides* and rice plants were higher than the other two species as indicated by the lower values of rice dry weight even when plants received high rates of nitrogen. It was appeared that *E. oryzoides* was a strong competitive to the rice than the two other species as it cause more reductions in rice tillers and its dry weights. Increasing nitrogen level up to 90 kg/ha, enhanced rice growth when it competed with *E. crus-galli* or *E. phyllopogon* more than when rice was competed with *E. oryzoides*. Similar results on *E. crus-galli* were reported by **Ampong-Nyarko and De Datta (1992), Shebl (2003).**

In addition, **Zimdahl (1988)** showed that usually weeds absorb large amounts of mineral nutrients at a faster rate than crop, as they have well developed root systems that derive a greater benefit from applied fertilizer.

D-1-5. Effect of the interaction between *Echinochloa* species and duration competition:

Data in Table 14, illustrates the development of rice tillers and dry weight of rice plants at complete flowering stage as two main factors determining the degree of competition encountered by different durations of competition and weed species. It is obvious that presence of the three different species of *Echinochloa* for 20 days or more in the life of the

transplanted rice crop produced a measurable reduction effects on tillering capacity of rice when it was estimated at harvest. These reductions were increased with increasing the duration of competition up to 60 DAT.. **Foin *et al* (2005)** reported that the earlier watergrass is removed from the rice stand, gave the less final reduction in rice tillers and panicle number. Similar results were reported earlier by **Noda *et al* 1968, Smith 1968, 1970,1988 and Noda (1973).** Also at harvest the survival rice tillers in the weed free plots were lower, may be due to the intraspecific competition occurred among rice plants. Reduction in numbers of rice tillers obtained due to 20 days competition from the three species of *Echinochloa* were lowers .

While, the percentage of reductions due to 60 days competition of *E. crus-galli*, *E. oryzoides* and *E. phyllopogon* were higher (29, 26 and 26%, respectively). Maximum reductions were occurred when the different species of *Echinochloa* were kept grown with rice for all the grown season.

The data recorded in Table (14) on dry weight of rice plants per hill at complete flowering show that rice must kept weed free to avoid reductions in its growth. A short period of 20 days competition caused 6, 11 and 5% reduction in rice dry weight, respectively from *E. crus-galli, E. oryzoides* and *E. phyllopogon* species. These reductions increased gradually with increasing periods of *Echinochloa spp* competition. For example, if *E. crus-galli*, *E. oryzoides* and *E. phyllopogon* were allowed to grow up 60 days after transplanting or all season with rice they caused 30 or 39%, 31 or 35% and 29 or 30% reduction respectively. **Shebl (2003)** found that 10 plants/m2 of *E. crus-galli,* significantly reduced the dry weight of rice. Dry weight of rice plants is a useful measure because it gives an idea of when the appropriate time of weed or when rice can withstand weed competition and then kept weed –free (Table 14).

D-1-6- Effect of the interaction between nitrogen levels and duration of competition of *Echinochloa* species:

Fertilization delay is somehow more effective, but it is dependent on weed proportion and specific competitive interaction. *E. oryzoides* is little affected by fertilization delay, maintaining its competitive advantage over rice, but least so when total densities is high. *E. phyllopogon* is more affected by a range of densities and so it may affected rice stands. **(Foin *et al* 2005).** Interference of *Echinochloa sp.* significantly affected the number of rice tillers per hill at harvest as well as the dry matter production of rice at flowering stage. The degree of interference was greatly affected by levels of nitrogen application (Table 15).

Numbers of rice tillers per hill were almost lower, may be due to the intraspecific competition of rice plants. The highest numbers of tillers per hill were higher in plants grown free from *Echinochloa spp* and were fertilized with 90 kg N/ha, followed by plants fertilized with 60 kg N/ha. A short competition period of 20 days did not affect the final tillering capacity of rice plants when grown under 0 or 30 kg N/ha. Application of 60 or 90 kg N/ha did not overcome the competitive effect of *Echinochloa spp* for 20 days on rice plants as they produced significantly lower tillering as compared to rice plant grown free from the weed. Increasing the competition period of the weed increased the reduction occurred in rice tillering production gradually. The lowest reduction were observed in plants received 90 kg N/ha (Table 15).

Also in Table 15, rice dry weight under high nitrogen level (90 kg N/ha) and weed-free condition was reported significantly highest, followed by dry weight of rice plants received 90 kg N/ha and were exposed to *Echinochloa spp* competition for 20 days as well as rice plants grown free from weed and were fertilized with 60 kg N/ha. Rice plants were suffered from *Echinochloa spp* competition for different periods. Maximum competition effects of *Echinochloa spp* were occurred in rice plants suffered from the weed for 60 days or season-long period in non-fertilized plots followed by rice plants suffered from season-long competition of the weed and received lower nitrogen level (30 kg N/ha). **Hassan and Rao (1994a)** showed the superiority of barnyardgrass in possessing the characteristics associated with competitiveness, which enables this weed to achieved more dry weight under the increased nitrogen levels than rice plants, consequently reduced tillering productions.

D-1-7- Effect of the interaction among *Echinochloa* species, nitrogen levels and duration of competition:

Dry weight of rice plants at complete flowering stage is an integrated parameter, which directly reflects the degree of competition of the three *Echinochloa spp* as well as the effect of nitrogen on the competitive ability of either rice or weeds (Table 16). The highest dry weight of rice plants was recorded in plots free from *E. phyllopogon* when they fertilized with 90 kg N/ha followed by rice plants grown free from *E. crus-galli* and received the 90 kg N/ha. The competition of *E. crus-galli* for 20 days did not cause a significant reduction effects on rice dry weight as compared to the weed-free condition at the same level of nitrogen application. Increasing competition period of *E. crus-galli* more than 20 days resulted in sharp reductions in dry weight. However, the results did not produce a significant differences between 40 and 60 days of competition or more on dry weight of rice. The results indicate that the differences in rice dry weights were not significant between periods of 40 and 60 days of competition of *E. crus-galli* competition in plots received 30 or 60 kg N/ha. The reduction in dry weight of rice due to 40 and 60 days of competition or more at 90 kg N/ha is significant. Moreover, there are a significant differences between 60 days and season-long competition period of *E. crus-galli* at 60 and 90 kg N/ha levels.

The competitive effects of *E. oryzoides* with rice plants for 20 days did not differ significantly from the weed-free rice plants received 30, 60 and 90 kg N/ha levels, while it is significant in non-fertilized treatment . It was appeared that *E. oryzoides* did produce a significant competitive effects when it left to grow with rice for 40 and 60 days periods or for season-long when both were grown together without supplying nitrogen fertilizer or when they supplied with 30 or 60 kg N/ha. At 90 kg N/ha level of fertilization, increasing the competition period of *E. oryzoides* to 40 days, it resulted in more reduction in rice dry weight. Increasing the competition period more

than 40 days produce more significant reduction in rice dry weights (Table 16). The competitive ability of *E. phyllopogon* on rice plants for 20 0r 40 days did not produce noticeable reductions in dry weight of rice when they did not receive nitrogen. Moreover, the differences in dry weight of rice competed from *E. phyllopogon* for 40, 60 days or all season-long at Zero kg N/ha not significant. Likewise, when rice plants were supplied with 30 kg N/ha and grown in association with *E phyllopogon* for 20 0r 40 days. It produced non-significant adverse effects on rice dry weights. Increasing competition period for 60 days exhibited the same level of reduction as compared with season-long competition period. Almost the adverse effects of *E. phyllopogon* on rice dry weight were smaller when rice grown under either 60 or 90 kg N/ha condition. When *E. phyllopogon* plants were removed after 20 days period of competition the addition of 20 kg /ha (first split)of nitrogen did not overcome their adverse effects, which is reflected by smaller dry weight. More significant reduced weight of rice plants was exhibited at 60 days competition period or more (Table 16). In general, at the same level of nitrogen and the same competition period it is clear to indicate that, the strong competitive adverse effect of *E. oryzoides* than the other two *Echinochloa* species.

D-2- Yield and its components:

Major yield components of rice crop were greatly influenced by the competition of *Echinochloa spp*, levels of nitrogen application as well as the durations of *Echinochloa spp* competition (Table 17).

D-2-1- Effect of *Echinochloa* species

E. crus-galli had caused the significance reduction effects on number of rice panicles per hill as well as numbers of filled grains per panicle due to its competition to rice plants. *E. phyllopogon* was the second in the drastic effects on both number of panicles per hill and number of filled grains per panicle. While, *E. oryzoides* did not affects the both characters of yield

attribution. The three species of *Echinochloa* were produced the same effects of panicle weight, panicle length and the weight of 1000-grains (Table 17). The results in Table (17) also indicated that, the significant lower harvest index and rice grain yields was due to adverse effect of *E. phyllopogon* as compared to effects of *E. crus-galli*. Similar data were reported by **Kruijf and Pons (1985); Sheble (2003) and Foin *et al* (2005) .**

D-2-2- Effect of nitrogen levels:

The rate of nitrogen applied to rice plants grown with *Echinochloa spp* was significantly a critical factor affected the major rice yield components (Table 17). For example, the number of rice panicles per hill was gradually and significantly increased with increasing nitrogen application up to 60 kg N/ha and decreased significantly again with increasing nitrogen application up to 90 kg/ha. Number of filled grains per panicle was significantly greatest with application of 90 kg N/ha followed by 30 kg N/ha. The lower number of filled grains was observed in plots received 60 kg N/ha and in non-fertilized plots. Other rice yield components did not responded significantly to different levels of nitrogen application (Table 17).

Harvest index of rice and rice grain yield were significantly superior when rice plants were received 90 kg N/ha, while they were inferior at 0 kg N/ha (Table 17). No significant differences in straw yield when rice plants were received 30 up to 90 kg N/ha (Table 17).

D-2-3- Effect of duration of competition of *Echinochloa* species:

It was clear that a short period of *Echinochloa spp* competition of 20 days (Table 17) started after transplanting, had caused a significant reductions in number of panicles per hill, number of filled grains per panicle and panicle weight. Increasing periods of competition to 60 days as well as season-long competition, gradually and significantly decreased all measured rice yield

components. Similar results were obtained by **Lakshman *et al* (1999).**The duration of *Echinochloa spp* competition approximately had a direct adverse effects on all major yield components of rice **Smith (1968, 1970, 1988); Azmi *et al* (1992); Hassan (1996a), Shebl (2003) and Foin *et al* (2005).**

Harvest index in weed-free plots as well as in plots suffered from 20 days period of competition were not significant, and it reduced gradually with increasing competition periods (Table 17). Straw yield of rice plants was superior in season-long duration of competition followed by weed-free plots, while it was inferior in plots suffered from 20, 40 and 60 days duration of weed competition. Rice grain yield was highest in weed free plots, and then reduced gradually with increasing periods of competition (Table 17).

D-2-4- Effect of the interaction between *Echinochloa* species and nitrogen levels:

Data recorded in Table (18) illustrated the interaction effects between the different species of *Echinochloa* and different levels of nitrogen application on number of rice panicles per hill as well as number of rice filled grains per panicle. When *E. crus-galli* was grown and competed with rice plants under non-fertilized condition, it reduced the production of rice panicles. Rice panicle production under the competition of *E. crus-galli* was significantly improved when it received 60 kg N/ha. Increasing nitrogen level to 90 kg/ha favoured weed growth and did not improve panicle productions as compared to the application of 60 kg N/ha (table 18). Likewise, when *E. oryzoides* was competed with rice, the application of 60kg N/ha was greatly improved the production of rice panicles. The production of rice panicles were non-significant when *E. phyllopogon* was competed with rice under fertilizer condition of 60 and 90 kg/ha. When *E. crus-galli* plants were grown in association with rice plants and received 60 kg N/ha, it significantly produced lower filled grains of rice as compared to non-fertilized plants.

However, increasing nitrogen rate to 90 kg/ha did not improve the filled grains significantly. Approximately, the production of rice filled grains were significantly higher when *E oryzoides* plants were grown in association with rice plants as compared to the two other species and it was increased with increasing nitrogen application from 60 to 90 kg/ha. The application of 90 kg/ha to rice plants which grown in association with *E. phyllopogon* plants is responsible for the better filled grains of rice as compared with the other nitrogen rates. It was clear to indicate that, the strong reduction effects of *E. crus-galli* on rice filled grains as compared to the two species of the weed when received different rates of nitrogen. **Andrade (1982)** reported that barnyardgrass interference with rice varieties and weed densities, duration of competition, high fertilization and maturity of rice cultivars.

The interaction between different species of *Echinochloa* and nitrogen levels on harvest index of Sakha 101 was significant (Table 18). When *E. crus-galli* was competed with rice, the maximum harvest index (36.03%) was achieved with adding 90 kg N/ha, followed by 60kg N/ha. The lower the harvest index was resulted from non-fertilized plants as well as the rice plants received 30 kg N/ha. The harvest index values of rice plants competed with *E. oryzoides* and received 0, 30 60 and 90 kg N/ha were not significant. However, harvest index values resulted from 90 kg N/ha did differ significantly from the harvest index values resulted from the interaction of *E. crus-galli* competition with rice plants received 60 and 90 kg N/ha.

Approximately, the rice harvest index of non-fertilizer rice and competed with the three species of *Echinochloa* were similar in significance. Moreover, harvest index values resulted from the grown of *E. phyllopogon* and received 30 up to 90 kg N/ha were also, similar in significance.

Straw yield of rice grown with *E. phyllopogon* and they were fertilized with 60 and 90 kg N/ha were better than non-fertilized plants (Table 18).

However, rice plants grown with *E. oryzoides* and they received 30 up to 90 kg N/ha produced almost similar straw yield, and they did not significantly differ from non-fertilized plants. Likewise, the straw yield of rice plants grown with *E. crus-galli* were significantly similar. These results indicated to the straw yield is not adequate measure in competition study.

Results of rice grain yield presented in Table (18) indicate that, after a season-long competition period of *Echinochloa* species, the superior grain yield was obtained when 15 plants/m^2 of *E. crus-galli* were planted with rice and received 90 kg N/ha. Lower or higher nitrogen application did not improve the competitive ability of rice against this weed. Inferior yield was obtained in non-fertilized rice plants in association with any species of *Echinochloa.*

Rice plants grown with *E. oryzoides* and received 90 kg N/ha produced better grain yield more than rice received higher or lower nitrogen. The same trend of grain yield was obtained from rice plants grown in association with *E. phyllopogon* and received different levels of nitrogen fertilizer. **Atkinson, (1999)** indicated that, applying fertilizer during the peak growth period of *E. oryzoides* was not favorable to rice.

D-2-5- Effect of the interaction between *Echinochloa* species and duration of competition:

The reductions occurred in number of rice panicles per hill, number of filled grains per panicle and panicle weight of rice were closely correlated with the different periods of competition of the three species of *Echinochloa* (Table 19). The heights panicles production, filled grains and panicle weight of rice plants were obtained from rice plants grown all the season free from the different species of *Echinochloa* with the presence of the weeds for different periods. Removed of *E. crus-galli* from rice plants after 20 days of competition stored after transplanting caused 14% reduction in panicles production. This reduction percentage was increased significantly with

increasing periods of competition. For example, increasing competition period of *E. crus-galli* to 60 days or for all the season, production of rice panicles were reduced to 40 and 45%, respectively. Likewise the respective reduction percentage occurred due to 60 days period of competition or all the season of *E. oryzoides* or *E. phyllopogon* were 35 and 43% or 36 and 44%, respectively. This results indicated that, *E. crus-galli* was most competition and greatly affected major rice yield components than the other two species (Table 19).

Removed of *E. crus-galli* plants after 20 days of growth with rice did not cause significant reduction effect on rice filled grains per panicle. While, these reductions of the same period were significant with the other two species. Competition periods of 40 and 60 DAT from *E. crus-galli*, resulted in non-significant reductions in filled grains of rice. However, it reduced significantly at 60 days from *E. oryzoides* or *E. phyllopogon* competition. Season-long duration of competition of *E. crus-galli* or *E. phyllopogon* resulted in the highest (non-significant) reduction in rice filled grains (29 and 34% respectively). Reductions in weights of rice panicles were manly dependent on duration of competition of the different species of *Echinochloa* (Table 19). For example, the removal of *E. crus-galli* or *E. oryzoides* plants after only 20 days of competition with rice plants did not reduce the weight of panicles significantly. While, this reduction was significant with *E. phyllopogon*. A period of 40 days of competition of the three species of *Echinochloa* after transplanting produced similar reductions in panicle weights. However, they did not differ significantly from the reduction effects of 20 days competition. Increasing the competition period of the three species of *Echinochloa* to completed the growing season of rice, resulted in higher significant reductions in panicle weights of rice as compared to 60 days period of competition. However, the reduction in panicle weight occurred due to the competition of *E. phyllopogon* for all the season was significantly

higher as compared to *E. crus-galli* (Table 19). Similar results were revealed by **Roa and Moody (1992) and Foin *et al* (2005).**

As indicated in Table (19) harvest index (%), straw and grain yields of rice were strongly affected by different periods of weed competition of the three species of *Echinochloa.* Highest harvest index values were demonstrated in weed-free rice plots as well as when *E. crus-galli* or *E .oryzoides* were removed after 20 days from transplanting and the plots were kept free from both species. Increasing period of competition to 60 days or more resulted in significantly greater reduction in harvest index value. Lowest values of harvest index were demonstrated in rice plots suffered from season-long competition of the three species of *Echinochloa*.

Competition from either species of *Echinochloa* for 20 days were enough to exhibit a significant reduction in straw yield of rice plants (Table 19). Increasing periods of competition of all *Echinochloa* species gradually increased values of straw yields especially with 60 days of competition as well as season-long competition of the three species of *Echinochloa*. Crop yield can be defined as a function of weed density and the duration of weed-crop interference **(Zimdahl, 1980 and Smith, 1988.**

Potentiality of rice cv. Sakha 101 grain yield was reduced significantly due to the powerful competition of *Echinochloa spp* for different durations after transplanting (Table 19). For example, grain yield of rice were reduced by 10, 25, 35 and 61% due to the severity of *E. crus-galli* competition for 20, 40, 60 days and season-long duration, respectively. The respective grain yield losses due to *E. oryzoides* were 7, 19, 35 and 63% and 9, 19, 34 and 58% due to *E. phyllopogon* in the same order. It is appeared that the season-long competition of *E. crus-galli* and *E. phyllopogon* produced significant higher reduction effects on grain yields more than *E. oryzoides*.

Rice plants can not recover well after a short period of 20 days competition of *Echinochloa spp.* These results are in agreement with the results obtained by **Salah-UL-din (1994).**

D-2-6- Effect of the interaction between nitrogen levels and duration of competition of *Echinochloa* species:

It is clear in Table (20) that the values of the three major rice yield component were dependent mainly on the rate of nitrogen application as well as the effects of the different durations of competition. The number of rice panicles per hill in the non-fertilized plots were highest where no competition was occurred. However, it was reduced greatly with increasing competition periods of *Echinochloa spp* competition. For example, the panicle productions were decreased 17%, 29% and 37% due to deeping competition of *Echinochloa spp* with rice for 20, 40 and 60 days after transplanting. Rice panicles production in weed-free plots received 30 kg N/ha were little higher without any significant as compared to non-fertilized weed-free-plots. Rice panicles production were reduced by 13, 27, and 37%, respectively to 20, 40 and 60 days duration of competition. Such reductions were lower as compared with the non-fertilized rice (Table 20). It means that this level of nitrogen has little influence in overcoming competition effects. Increasing nitrogen rate to 60 kg/ha benefited rice plants in weed-free plots and resulted in the highest number of rice panicles per hill. However, considerable reductions were found in panicle production when competition of *Echinochloa spp* were occurred. Panicle production of rice at this situation of nitrogen rate was reduced 15, 28, and 36% due to 20, 40, and 60 days periods of competition. The respective reductions in panicle production at 90kg N/ha were 13, 32 and 37% indicating that increasing nitrogen to rice plants suffered from *Echinochloa spp* competition did not help rice plants to recover.

Number of filled grains per panicle in weed-free rice plots did not differ significantly from either when they did not receive nitrogen or received

30 or 60 kg N/ha. However, number of filled grains in rice plants received 90kg N/ha was significantly higher than in rice plants received 60 kg N/ha. A short period of 20 days competition did not effect the number of filled grains when rice received 90 kg N/ha (Table 20). Moreover , a 40 days period of *Echinochloa spp* competition caused a non-significant number of rice filled grains when rice plants were untreated or treated with 30 up to 90 kg N/ha. Rice plants in treatment of season-long competition period of *Echinochloa spp* and were treated with 90 kg N/ha produced better filled grains as compared with the same situation but treated with 30 or 60 kg N/ha as well as non-fertilized rice plants.

The weight of 1000-grain was not adequate measurement in determine the adverse effects of *Echinochloa spp* on rice. For example, weight of 1000-grain of rice in weed-free rice plants or in rice plants suffered from 20, 40 and 60 days period of competition were almost non-significant. While, rice plants suffered the all season from *Echinochloa spp* competition and treated with 90 kg N/ha produced significantly better weight of 1000-grain as compared to rice plants treated with 0, 30, and 60 kg N/ha.

Duration of *Echinochloa spp* competition and level of nitrogen application both together significantly affected the production of rice grain yield (Table 20). The maximum potential of rice grain yield was obtained in weed-free rice plots received the highest nitrogen level (90 kg N/ha). As compared to other levels of nitrogen application, it produced 21, 13 and 8% more grain yield, respectively than in plots received 0, 30 and 60 kg N/ha. At the same level of nitrogen application, crop yields reduced significantly with increasing period of *Echinochloa spp* competition. At the same duration of competition, crop yields increased significantly with increasing level of nitrogen application.

For example, after a short period (20 days) *Echinochloa spp* competition, crop yield increased 10, 14 and 21% respectively with increasing nitrogen level from zero kg N/ha to 30, 60 and 90 kg N/ha (Table 20).

It is clear that, the percentage of reduction was increased with increasing duration of competition at 90 kg N/ha. For example, the percentage of reduction in crop yields reached 35% due to 60 days of weed competition with the crop when received 90 kg N/ha as compared to non-fertilized plots. Moreover, the crop reduction increased from 35% to 42% with season-long period of competition. Nevertheless, no significant reductions were observed between rice plants received 0, 30 and 60 kg N/ha and were suffered from season-long competition of *Echinochloa spp*. These results may due to the highest level of nitrogen benefited the weed plants more than rice plants. These findings are in harmony with these obtained by **Stauber *et al* (1991), Hassan and Roa (1994b) and Shebl (2003).**

D-2-7- Effect of interaction among *Echinochloa* species, nitrogen levels and duration of competition of *Echinochloa* species:

Based on results recorded in Table (21) it is quit clear that the interaction effects between nitrogen application levels and durations of competition of the three species of *Echinochloa* on number of panicles per hill was significant. Competition effect of the three species of *Echinochloa* at the same duration in plots did not received nitrogen did not differ significantly. Likewise, when plots were received 30 kg N/ha except for 40 days period of competition.. While, at 60 kg N/ha level, the competition effects of the three species of *Echinochloa* were significant at 40 and 60 days periods. Increasing nitrogen application rate to 90 kg/ha, approximately increased the drastic effect of *E. crus-galli* on panicles production especially after 20 days duration of competition as well as the season-long duration. Moreover, at a 60 days duration of competition of *E. crus-galli* exhibited more reduction effect on panicle production than *E .oryzoides*.

Approximately, the rice panicle production per hill was better when rice had received 60 kg N/ha in weed-free plots. At zero fertilizer nitrogen level, the reduction effect of the three species of *Echinochloa* on rice panicles production was increased greatly from 20 days period of competition after transplanting to 40 days period of competition or more. At 30 and 60 kg N/ha of nitrogen, the same trend was occurred from *E. crus-galli* as well as *E. phyllopogon*. While, the same greater reduction effects on panicles production were occurred from the three species of *Echinochloa* after 20 days period of competition.

The reductions in panicles production due to *E. crus-galli* competition for long-season were not significant at all nitrogen levels. While, these reductions due to 60 days period of competition were lower when rice plants were received 30 or 60 kg N/ha as compared with non-fertilized plants or plants received 90 kg N/ha.

The reductions effects occurred in rice panicles production due to *E. oryzoides* competition for 60 days or more were not significant when plants were received 0 or 30 kg N/ha. At 60 and 90 kg N/ha, *E. oryzoides* caused lower reduction in panicles productions after 60 days or more of competition. *E. phyllopogon* competition up to 60 days or more caused the greatest reduction in rice panicles when plants received 30 or 60 kg N/ha.

The competitive effects of the three species of *Echinochloa* and its duration of competition with rice as well as level of nitrogen application on rice harvest index were illustrated in Table (21). Harvest index was decreased gradually with increasing duration of competition of the three species regardless of the level of nitrogen. Regarding the competition of the three species of *Echinochloa,,* the season-long duration of competition of each species resulted in non-significant reduction in the harvest index. The variance in the harvest index of rice in plants suffered only from 20 days duration of competition of the three species of *Echinochloa* and was not significant at all nitrogen levels as compared with the harvest index of the weed-free plots. After this short period of competition, harvest index reduced significantly at all levels of nitrogen fertilization. At zero level of nitrogen fertilizer and the same duration of competition, harvest index of rice was significant higher when *E. oryzoides* was grown with rice, except for season-long duration of competition. *E. oryzoides* reduced the harvest index significantly more than others. At 30 kg N/ha, the harvest index of rice plants suffered from any species of *Echinochloa* and was not significant at the same duration of competition started from 20 days up to season-long duration.

When nitrogen was applied at 60 kg N/ha, harvest index of rice crop suffered from 40 and 60 days period of competition of *E. crus-galli* and was significantly higher as compared with *E. phyllopogon*. Increasing nitrogen application to 90 kg N/ha did not improve the harvest index of rice after each period of competition as compared with improved effects of 60 kg N/ha.

A considerable differences in the rice straw yields were observed due to the interaction effects of different duration of competition of *Echinochloa spp* and different levels of nitrogen fertilization (Table 22). At the same level of nitrogen it clear that, increasing duration of competition of the three species of *Echinochloa* up to all-season, resulted in higher straw yield of rice than shorter period of competition. Increasing nitrogen application from zero up to 90 kg N/ha did not change the values of rice straw yields significantly when the comparison is made between the same duration of competition of each weed species. The differences between the effects of the three species of *Echinochloa* occurred during the same period of competition at any levels of nitrogen were not clear in most cases, except for 40 days and season-long durations at zero nitrogen levels, 60 days duration of competition at 30 kg N/ha, 20 days duration of competition at 60 and 90 kg N/ha.

The severity of competition of *Echinochloa spp* occurred at different durations were significantly affected by the level of nitrogen fertilizer (Table 22). At all nitrogen levels, rice grain yields significantly reduced gradually in both seasons with increasing duration of competition from early duration of 20 days after transplanting to all season-long duration. At zero nitrogen application the grain yield loss in both season were 10 , 29 and 21, 42 and 28, 59 and 65%, respectively due to 20, 40, 60 and season-long duration of competition. While, the respective grain yield losses in both seasons were 11 and 6, 25 and 15, 37 and 35, 61 and 64% for 30 kg N/ha, 9 and 9, 23 and 19, 41 and 32, 66 and 61 % for 60 kg N/ha, and 7 and 12, 18 and 18, 32 and 30 and 53 and 60% for 90 kg N/ha. It is clear that the reduction in rice grain

yield did not greatly depended on nitrogen level but it greatly depended on duration of weed competition. However, with short period of competition the grain yield losses were decreased with increasing nitrogen fertilizer. In general, **Hill *et al* (1982)** reported that nitrogen had a marked effect on the competition relationship between barnyardgrass and rice. Increasing nitrogen in the absence of weed competition produced significantly increased yield. At low barnyardgrass levels yield still responded positively with increasing nitrogen, however, at high levels of barnyardgrass, yields were reduced with increasing nitrogen. This interaction between nitrogen and barnyardgrass was highly significant.

In study on rice barnyardgrass competition, **Perera *et al* (1992)** recorded below ground competition for nutrients was more important than the above ground competition for height. Utilizing a split fertilizer treatment application as opposed to a 100% pre plant fertilizer application may reduce the competition of early and late watergrass with rice, but may also reduce the stability rice yields. Since domesticated rice has longer growing season than early watergrass, applying some of nitrogen later in the season showed leave more nitrogen available for the rice.

It was initially hypothesized that since late watergrass grow throughout the season rather than during the beginning of the season like early watergrass, that late watergrass would not show any yield reduction due to splitting the fertilizer application.

The competitive advantage of *Echinochloa spp* is attributed to it's a C4 plants with high photosynthetic rates and corresponding high growth rate (unlike rice, which is a C3 plant), high potential to acclimatize to a changing environment; and more efficient seed production **(Kim and Moody 1989).**

Most of the modern cultivars of rice with improved plant type have been developed with a reduced ability to compete with weeds and pored adaptation to weedy situation **(Moody 1979).**

Potential rice grain yield losses caused by different duration of competition of the three species of *Echinochloa* as well as the response effects of different nitrogen levels were demonstrated in Table (22). Early short period of competition of *E. crus-galli*, *E. oryzoides* and *E. phyllopogon* at zero nitrogen application reduced grain yield by 12, 6 and 10% respectively. Grain yield losses caused by the short period of competition of *E. crus-galli* were reduced to 8,7 and 10 %, respectively with increasing nitrogen level from zero to 30, 60 and 90 kg N/ha. While, losses were increased slightly to 7, 7 and 9 % due to competition of *E. oryzoides* at 30, 60 and 90 kg N/ha. Crop yield losses occurred after 20 days period of *E. phyllopogon* competition were reduced from 12% at 30 kg N/ha to 8% at 60 and 90 kg N/ha.

Competitiveness of *Echinochloa spp* were increased with increasing their durations, regardless of nitrogen fertilizer level. Therefore, increasing competition period to 40 days significant grain yield losses were occurred from the three *Echinochloa spp* at zero, 30, 60 (with exception of *E .phyllopogon*), and 90 (only for *E. crus-galli*) kg N/ha. Increasing the duration of competition of *Echinochloa spp* to 60 days or long-season periods, resulted in gradually increasing in grain yield losses. In all saturation of nitrogen fertilizer, the grain yield losses caused by season-long competition of *Echinochloa* species were significantly greater as compared to the drastic effects of 60 days period of competition. Approximately grain yield losses due to season-long competition were higher at 60 kg N/ha than at 90 kg N/ha. Among the effect of the three species, competitiveness of *E. crus-galli* was stronger at 40 days duration when no nitrogen was applied than the other two species. While, competitiveness of *E. oryzoides* was stronger in season-long duration at zero nitrogen fertilizer. Nitrogen fertilizer is used to improve crop growth and yield, but may worsen the weed problem.

Moody (1981) pointed out that increased nitrogen fertilizer increased yield. It is also apparent that with jus barnyardgrass, increasing nitrogen fertilizer from 0 to 60 kg/ha decreased yield. Only after a further doubling of nitrogen increased the yield . Even then, yield was lower than the same amount of fertilizer with no weeds . Nitrogen is the first nutrient to become limiting in most instances of weed-crop competition.