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# Enhancing chemical weed control in drill-seeded rice by using preceding winter crops

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## Abstract

In the summers of 2021 and 2022, two field experiments were conducted at Gemmeiza Research Station, Agriculture Research Center, Gharbia governorate, Egypt. The purpose of this study was to evaluate the effectiveness of four herbicidal combinations: FL Inpul at 20 g feddan$^{-1}$ (feddan = 4200 m² = 0.420 hectares = 1.037 acres), Nominee at 0.8 L feddan$^{-1}$, FL 1.5 litres feddan$^{-1}$ for Basagran, 2.0 litres feddan$^{-1}$ for Sitron, and FL Inpul at 20 g feddan$^{-1}$, Sitron at 2.0 l feddan$^{-1}$, FL Basagran at 1.5 l feddan$^{-1}$ and two hand weedings in addition to the unweeded check that is beneath barseem and wheat as the previous winter crops. The main findings showed that the herbicidal combinations had a significant impact on controlling the weeds that were present, along with increasing the production and profitability of rice under either berseem or wheat; the effect was greater under barseem. Superior hand weeding was used twice under both of the previous crops in all cases when combining herbicidal combinations.

*Keywords*: rice, preceding crop, weeds, herbicides, economic feasibility.

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# 1. Introduction

Rice (*Oryza sativa* L.) is one of the most important critical crops for food security; it feeds approximately 50% of the world's population and more than 21% of human caloric requirements (Mohidem, 2022; Zhao *et al*., 2020). Rice is cultivated on approximately 160 million hectares worldwide and consumes 35-45% of the world's irrigation water (Bouman, 2012). Between 1994 and 2019, global paddy rice production increased significantly. Rice (*Oryza sativa* L.) is a major summer cereal crop not only in Egypt but also globally. Egypt's total production from 554205 hectares was 4, 893, 507 tons (FAOSTAT, 2021). In recent years, Egyptian rice production has focused on increasing water productivity by releasing new rice cultivars with short duration, high yielding ability, and high quality, as well as increasing the area cultivated with direct seeded rice as dry seeds in dry soil to reduce applied irrigation interstices while yielding a profit. The preceding crop has a significant impact on rice grain output and its influencing factors. According to Tagour *et al*. (2016), show that broadcasting rice after berseem reduced the dry weight of both dicot and monocot weeds. Clover's high N level is due to its ability to biologically fix N, which is reflected in elevated levels of amino acids and protein, resulting in a low C:N ratio, which raises the mineral N level in the serial (Thilakarathna *et al*., 2016). In a specialized irrigated hybrid rice system, a winter cover crop of leguminous legumes (clover) reduces nitrogen requirements while increasing grain yield. Furthermore, clover cultivation increased mineral and microbial N availability in the soil by 35% and 6.5%, respectively. In the rice hybrid, the optimal nitrogen rate was reduced by 14.1% (Weinert *et al*., 2023). White clover in rice rotation increases rice yield while reducing weed infestation (Cho and colleagues, 2003). Legumes have a high capacity for biological nitrogen supply to the soil, which can supply nitrogen to cereals while reducing the need for synthetic fertilizers (Carlos *et al*., 2022a; Stagnari *et al*., 2017). It has been reported that using legumes increases soil organic carbon and phosphorus levels (Carlos *et al*., 2022b). Weed control is important for increasing rice productivity because weeds associated with plants cause high losses ranging from 35 to 100% (Mamun *et al*., 2013). To control the complex of weed flora in rice, high efficiency herbicides in combination with broad spectrum nature are currently required. Fenoxaprop and bentazon combined successfully suppressed both grassy and broad-leaved weeds while enhancing rice yield, according to studies by Zhang *et al*. (2005) and Chouhan *et al*. (2015). 37% of the weed flora in rice was found to be grasses, 33% to be sedges, and 30% to be broad-leaved weeds. When compared to standard propanil-based programmes, Talbert and Burgos (2007) found that Penoxsulam did not harm rice, however it increased yields. When compared to the control treatment, penoxsulam reduced the fresh weight of grassy weeds by (13.6%) and total weeds by 39.2%. According to Jamshid *et al*. (2012), thiobencarb combined with bentazon, oxadiargyl combined with bentazon, and butachlor combined with bentazon yielded 3454, 3390, and 3349 kg/ha, respectively, when compared to three-time manual weeding (3044 kg ha$^{-1}$). Grain yield was increased by 41 and 18%, respectively, in the first season, and 44 and 31%, respectively, in the successive season, when compared to the untreated control (Mousa and Noreldin, 2015). Grow broadcast-seeded rice after berseem according to Tagour et al. (2016); the highest weed control and profitable feasibility were obtained with each of Rainbow at 0.4 L feddan$^{-1}$ + Inpul at 20 g feddan$^{-1}$, Rainbow at 0.4 L feddan$^{-1}$ + Basagran at 1.5 L feddan$^{-1}$, Sitron at 0.75 L feddan$^{-1}$ + Enpul at 20 g feddan$^{-1}$, and Saturn at 2.0 L feddan$^{-1}$ + Basagran at 1.5 L feddan$^{-1}$. Ottis *et al*. (2004) and Jagtap *et al*. (2018) establish that herbicidal combinations of (Saturn 2.0 L feddan$^{-1}$ + Inpul 20 g feddan$^{-1}$), (Saturn 2.0 L feddan$^{-1}$ + Basagran 1.5 L feddan$^{-1}$), (Saturn 1.0 L feddan$^{-1}$ + Inpul 20 g feddan$^{-1}$) and hand weeding doubly reduced dry weight of total weeds by 88.6, 86.6, 84.2, and 79.0% , respectively, as compared to the unweed check. Abd El-Naby *et al.* (2018) found that spraying bispyribac- sodium 2% SL at 0.0381 kg ai ha$^{-1}$ or fenoxaprop-ethyl 7.5% EW at 0.0625 kg ai ha$^{-1}$ alone combined with halosulfuron methyl 75% WG at 0.0357 kg ai ha$^{-1}$ prescribed levels as post-emergence herbicides at 22 and 35 days after sowing resulted in the ultimate rice grain yield and best weed control. Kenapar *et al.*, (2019) found that herbicidal combinations of (Saturn 2.0 L fedan$^{-1}$ + Inpul 20 g fedan$^{-1}$), (Saturn 2.0 L fedan$^{-1}$ + Basagran 1.5 L fedan$^{-1}$), (Saturn 1.0 L fedan$^{-1}$ + Inpul 20 g fedan$^{-1}$), (Saturn 1.0 L fedan$^{-1}$ + Basagran 1.5 L fedan$^{-1}$) decreased dry weight of total weeds by (88.6, 86.6 and 84.2 %). On the other hand, increased straw yield by (46.7, 46.5, 37.9 and 37.8 %) and grain yield by (51.0, 51.1, 40.2 and 40.3 %), respectively, as compared to the unweeded check, also, increase economic return to farmers. Jaiswal *et al.* (2022) showed that herbicides (oxadiargyl, fenoxaprop-p-ethyl + ethoxysulfuron, and oxadiargyl, penoxsulam + cyhalofop-butyl) were shown to be more effective in controlling weeds in rice (92-95% weed control effectiveness). The aim of this work was to assess the effect of some herbicidal combinations on weed control and yield of rice crop under berseem and wheat as winter crops in Gharbia Government, Egypt.

## 2. Materials and methods

The current research studied the effects of preceding crops (berseem and wheat) and six weed control treatments (four herbicide combinations, hand weeding twice, and untreated check) on weed control, yield, and its components of rice drill, *Oryza sativa*, variety Sakha 108, during the 2021 and 2022 seasons at the Experimental Farm of Gemmeiza Research Station, Gharbia Governorate, Egypt. The soil texture was clay (Table 1), according to Jacson (1973). Prior to planting, 100 kg feddan$^{-1}$ of steady calcium super phosphate (15.5% $P_2O_5$) was bestowed to the soil to ready it. In the first and successive seasons, planted rice was sown on May 20 and 25, respectively. About 60 kg of rice are applied every feeding. All prescribed agronomic proceedings for drill-seeded rice, including preparation of the soil, fertilization, and irrigation (nitrogen fertilizer urea 46.5% N, at 150 kg feddan$^{-1}$, portioned in three equal doses after planting), were carried out.

Table (1): Physical and chemical properties of the experimental soil (0-30 cm) in 2021 and 2022 seasons.

| Seasons | Particle size distribution | | | Soil texture | Chemical analyses | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sand (%) | Silt (%) | Clay (%) | | EC (ds m$^{-1}$) (1:5) | pH (1:1) | Organic matter (%) | Available (mg kg$^{-1}$) | | |
| | | | | | | | | Total (%) | P (ppm) | K (ppm) |
| 2021 | 17.2 | 32.0 | 51.8 | Clay | 2.19 | 7.75 | 1.42 | 28 | 6.01 | 410.0 |
| 2022 | 18.5 | 30.2 | 49.3 | Clay | 2.74 | 7.81 | 1.52 | 31 | 7.05 | 375.0 |

Four replicates were used in the split plot design of the experiment. The size of the subplots was 10.5 m$^2$ (3.0 m × 3.5 m). Each experiment consisted of twelve treatments, as follows:

The main plots (preceding winter crops):

1: Wheat (*Triticum aestivum*).
2: Berseem (*Trifolium alexandrinum*).

The sub plots (Herbicidal combinations):

$T_1$: Sitron 50% EC (thiobencarb) at the rate of 2.0 l feddan$^{-1}$ after 7 days after planting + Inpul 75% WG (halosulfuron-methyl) at the rate of 20 g feddan$^{-1}$ after 21 days after planting.

$T_2$: Sitron 50% EC (thiobencarb), at the rate of 2.0 l feddan$^{-1}$ after 7 days after planting + Basagran 48% AS (bentazon), at the rate of 1.5 l feddan$^{-1}$ after 21 days after planting.

$T_3$: Nominee 2.0% SL (bispyribac-sodium) at the rate of 0.8 l feddan$^{-1}$ after 15 days after planting + Inpul 75% WG (halosulfuron- methyl) at the rate of 20 g feddan$^{-1}$ after 30 days after planting.

$T_4$: Nominee 2.0% SL (bispyribac-sodium) at the rate of 0.8 l feddan$^{-1}$ after 15 days after planting + Basagran 48% AS (bentazon) at the rate of 1.5 l feddan$^{-1}$ after 30 days after planting.

$T_5$: Hand weeding twice at 30 and 45 days after planting.

$T_6$: Untreated check.

Herbicides treatments were sprayed by knapsack sprayer CP3 with water quantity of 200 l feddan$^{-1}$. Nomenclature of herbicides are listed in Table (2).

Table (2): Nomenclature of the studied herbicides.

| Trade name | Common name | Chemical name | Target weeds | Site of action |
|---|---|---|---|---|
| Nominee 2% SL | Bispyribac-sodium | [2-(2,2-difluoroethyl)-N-(5,8-dimethyl [1,2,4] triazolo [1,5-c] pyrimidin-2-yl)- 6-(trifluromethyl) benzenesulfonamide] | Grassy+ sedges | Inhibition of ALS (AHAS) |
| Sitron 50% EC | Thiobencarb | [S-4-chlorobenzyl diethyl (thiocarbamate)] | Grassy+ sedges | Inhibition of lipid synthesis - not ACCase |
| Bazagran 48% AS | Bentazon | [3-isopropyl-1H-2, 1, 3-benzothiadiazin-4(3H)-one 2, 2-dioxide] | Broadleaf weeds+ sedges | Inhibition of PS II |
| Inpul 75% WG | Halosulfuron-methyl | [methyl 3- chloro -5- (4,6- dimethoxy pyrimidin-2-yl carbamoyl sulfonyl)-1 et hylpy-razole-2.2. carboxylate] | Broadleaf weeds+ sedges | Inhibition of ALS (AHAS) |

### *2.1 Data recorded*

#### *2.1.1 On annual weeds (g $m^{-2}$)*

Weed estimation was carried out at 72 and 92 days after planting. Weeds were hand pulled from one square meter chosen at randomly from each plot. Weeds were air- dried before being steadily baked for 48 hours at 70°c. The dominant weed species counted in the experimental plots in both seasons were shown in Table (3).

Table (3): The names of weeds associated with rice crop during 2020 and 2021 seasons.

| Weeds categories | Scientific name | Common name: | Family |
|---|---|---|---|
| Broadleaf weeds | *Ammannia auriculata* Willd | Tooth cup | Lythraceae |
| | *Eclipta alba* (L.) | Trailing Eclipta Plant | Asteraceae |
| Grassy weeds | *Echinochloa colonum* (L.) | Jungle rice | Poaceae |
| | *Dinebra retroflexa* (Vahl) Panz | Viper grass | Poaceae |
| | *Echinochola crus-galli* (L.) | Barnyard grass | Poaceae |
| Sedges weeds | *Cyperus difformis* (L.) | Small flower umberella plant | Cyperaceae |
| | *Cyperus rotundus* (L.) | Purple nutsedge | Cyperaceae |

#### *2.1.2 On weeds susceptibility*

Weed species susceptibility to herbicides susceptibility index was gauged according to Frans and Talbert (1977) as follows: 1. Susceptible (S) = >90%. 2. Moderately susceptible (MS) = >80-90%. 3. Moderately tolerant (MT) = > 60-79%. 4. Tolerant (T) = < 60%.

#### *2.1.3 On rice characteristics*

Samples were gathered from a chosen area of one square meter in the center plot, and 10 rice plants were randomly selected at harvest. The following characters were identified: number of tillers $m^{-2}$, number of panicles $m^{-2}$, plant height (cm), panicle length (cm), grain weight per panicle (g), and the grain yield (ton feddan$^{-1}$) to be estimated at harvest from the yield of the entire plants of the whole plot.

#### *2.1.4 Economic feasibility*

Economic feasibility for the results was befitted to investigate the differences between the different studied factors to get the highest profitability by using some economic criteria such as gross income, net income, gross margin, benefit cost$^{-1}$ ratio and profitability. Economic criteria were used according to the method described by Dunan *et al.* (1995). Economic criteria were estimated from the following formulas:

1- Total costs = costs, fertilization, irrigation, insect, pathogen, and weeds control, harvesting and rental value feddan$^{-1}$ of land preparation, planting, post sowing activities.
2- Total income (GI) = (yield (ton feddan$^{-1}$) × price of ton (L.E.)) + (Straw yield (ton feddan$^{-1}$) × price of ton (L.E.).

3- Net income (NI) = total income - total cost (L.E.).
4- Profitability (P) = (net income / total costs).
5- Benefit / cost ratio (B/C) = (total income / total cost).

The average of rice price was 6500 and 9400 LE /ton of seed and 250 LE / ton of the straw in the two seasons, respectively.

*2.2 Statistical analysis*

Statistical analysis was carried out according to Gomez and Gomez (1984), using (MSTAT) computer software. The mean values were compared at 5% level of significance by using LSD test.

## 3. Results and Discussion

*3.1 Performance of the preceding crops and herbicidal combinations*

*3.1.1 On weeds (g m$^{-2}$)*

The presented weed species beneath untreated check were *Echinochloa colonum* L., *Echinochloa crus-galli* L. and *Dinebra retroflexa* Vahl as annual grasses, furthermore *Cyperus difformis* L. and *Cyperus rotundus* L. as sedge weed, with infestation rates was 0.511 and 0.707 ton feddan$^{-1}$ dry weight at 72 days after planting (DAP) in 2021 and 2022 summer seasons, respectively. While *Ammannia auriculata* Willd and *Eclipta alba* L. as annual broadleaf weeds, their infestation rates were 1.10 and 0.820 ton feddan$^{-1}$ dry weight of weeds at 72 (DAP) in both seasons, respectively. Information in Table (4) shown that the potential point of reference winter crops was significantly impact on the dry weight of broadleaf weeds and grasses plus sedges without then total at of 72 and 92 DAP in both seasons. In rice planting after clover, the significant reduction % on the dry weight of broadleaf weeds and grasses plus sedges were 7.27 and 19.73% of 72 DAP and 20.70 and 3.37% at 92 DAP in the first season, respectively, compared to rice planting after wheat. Whilst the significant reduction % on the dry weight of broadleaf weeds and grasses plus sedges was 10.77 and 12.39% at 72 DAP, and 9.80 and 15.82% at 92 DAP in the second season, respectively, compared to rice planting after wheat. On the other hand, all herbicidal combinations and hand weeding techniques were significantly reduced hand the dry weight of the presented weed species. That is true at 72 and 92 DAP in both seasons. In first season, these herbicidal combinations could be arranged in a descending or der for reducing the dry weight of broadleaf weeds, grasses plus sedges and their total at 72 DAP as follows: Nominee at 0.8 L feddan$^{-1}$ followed by (FL) Inpul at 20 g feddan$^{-1}$ ($T_3$) by 90.7 , 91.9 and 91.1% respectively, Nominee at 0.8 L feddan$^{-1}$ FL Basagran at 1.5 L feddan$^{-1}$ ($T_4$) by 90.2, 89.9 and 90.1 % respectively, Sitron at 2.0 L feddan$^{-1}$ FL Inpul at 20 g feddan$^{-1}$ ($T_2$) by 88.1, 89.6 and 88.6% respectively, Sitron at 2.0 L feddan$^{-1}$ FL Basagran at 1.5 L feddan$^{-1}$ ($T_1$) by 86.1, 85.9% respectively, and hand weeding twice ($T_5$)

by 59.6, 40.4 and 53.1% respectively, compared to untreated cheek. Whilst, the same previous respective herbicidal combinations were reduced significantly the dry weight of broadleaf weeds, grasses plus sedges and their total weeds at 90 DAP as follows: ($T_3$) by 91.4, 89.8 and 90.7% respectively, ($T_4$) by 89.9 , 90.6 and 90.2% respectively, ($T_2$) by 88.7, 87.9 and 88.4% respectively, ($T_1$) by 86.9 , 81.8 and 84.9% respectively, and ($T_5$) by 60.0, 39.9 and 52.3%, respectively compared to untreated cheek. Furthermore, the consequence obtained from the two surveys at 70 and 90 DAP in the second season showed a similar significant effect as those observed in the first season with minor differences. This consequence agreement with those attained by Mousa and Noreldin (2015).

Table (4): Performance of preceding crops and herbicidal combinations on dry weight (g $m^{-2}$) of annual weeds at 72 and 92 days after planting during 2021 and 2022 seasons.

| Treatments | Dry weight (g $m^{-2}$) of annual weeds | | | | | |
|---|---|---|---|---|---|---|
| | 72 DAP | | | 92 DAP | | |
| | Broadleaf weeds | Grasses & sedges weeds | Total annual weeds | Broadleaf weeds | Grasses & sedges weeds | Total annual weeds |
| | 2021 season | | | | | |
| Preceding crops: | | | | | | |
| Berseem | 63.7 | 42.3 | 105 | 65.5 | 60.3 | 125.8 |
| Wheat | 68.7 | 52.7 | 121.4 | 82.6 | 62.4 | 145 |
| LSD at 5% | 1.21 | 1.79 | NS | 1.58 | 1.02 | NS |
| Herbicidal combinations | | | | | | |
| T1. Sitron FL* Basagran | 33.6 | 17.1 | 50.7 | 34.3 | 29.9 | 64.2 |
| T2. Sitron FL Inpul | 28.7 | 12.7 | 41.4 | 29.5 | 19.9 | 49.4 |
| T3. Nominee FL Inpul | 22.4 | 9.8 | 32.2 | 22.4 | 17.3 | 39.7 |
| T4. Nominee FL Basagran | 23.6 | 12.3 | 35.9 | 26.3 | 15.4 | 41.7 |
| T5. Hand weeding twice | 97.6 | 72.5 | 170.1 | 104.3 | 98.8 | 203.1 |
| T6. Untreated check | 241.3 | 121.6 | 362.9 | 261.3 | 164.3 | 425.6 |
| LSD at 5 % | 11.17 | 9.55 | 19.07 | 17.34 | 21.66 | 29.54 |
| | 2022 season | | | | | |
| Preceding crops: | | | | | | |
| Berseem | 58.0 | 48.8 | 106.8 | 70.8 | 66.5 | 137.3 |
| Wheat | 65.0 | 55.7 | 120.0 | 78.5 | 79 | 157.5 |
| LSD at 5% | 1.46 | 1.78 | NS | 0.13 | 2.01 | NS |
| Herbicidal combinations | | | | | | |
| T1. Sitron FL Basagran | 25.2 | 24.5 | 49.7 | 33.6 | 31.5 | 65.1 |
| T2. Sitron FL Inpul | 25.9 | 19.8 | 45.7 | 26.5 | 26.3 | 52.8 |
| T3. Nominee FL Inpul | 20.5 | 13.3 | 33.8 | 20.2 | 22.7 | 42.9 |
| T4. Nominee FL Basagran | 23.1 | 17.9 | 41 | 26.4 | 18.1 | 44.5 |
| T5. Hand weeding twice | 102.7 | 61.1 | 163.8 | 116 | 103.7 | 219.7 |
| T6. Untreated check | 195.2 | 168.4 | 363.6 | 260.6 | 197.9 | 458.5 |
| LSD at 5 % | 12.76 | 13.54 | 16.34 | 21.72 | 19.78 | 18.73 |

FL = followed by.

### *3.1.2 Weeds susceptibility*

Data in Table (5) appeared weeds species susceptibility % to herbicides utilized agreeing to rating system described by Frans and Talbert (1977). Information uncovered those grassy weeds (*Echinochloa colonua* L. and *Echinochloa crus-ghali* L.) was more susceptible to Nominee at 0.8 L $feddan^{-1}$

and Sitron at 2.0 L feddan$^{-1}$, whereas *Echinochloa colonua* L. and *Cyperus difformis* L. were more delicate to than ($T_1$- Sitron 2 L feddan$^{-1}$ FL Basagran 1.5 L feddan$^{-1}$) and ($T_2$- Sitron 2 L feddan$^{-1}$ FL Inpul 20 g feddan$^{-1}$) combination. On the other hand, *Ammannia auriculata* Willd and *Eclipta alba* L. as broadleaf weeds and *Cyperus rotundus*, L. as sedges at 72 DAP, were tolerant for Sitron 2.0 feddan$^{-1}$ and Nominee at 0.8 L feddan$^{-1}$ meanwhile *Dinebra retroflexa* Vahl was moderately tolerant with all used herbicides at both 72 DAP, in 2021 season, *Echinochloa colonua* was sensitive to Sitron 2.0 feddan$^{-1}$ FL Basagran 1.5 L feddan$^{-1}$ or Inpul 20 g feddan$^{-1}$ in 2021 season, but it was moderately susceptibility to other treatments (*Ammannia auriculata*, *Eclipta alba* and *Cyperus rotundus*) was tolerant to Nominee at 0.8 L feddan$^{-1}$ and Sitron at 2.0 L feddan$^{-1}$ at 72 DAS in 2021 season, while was moderately susceptible to the other treatments. The most effective treatments in controlling total annual weeds in both seasons where gave hand weeding twice treatment by 53 and 55 %, while Nominee at 0.8 L feddan$^{-1}$ FL Inpul at 20 g feddan$^{-1}$ gave 91 and 91% in 2021 and 2022 seasons, respectively, as compared to unweeded check without significant differences between them. These come about had the same slant at second survey and second season. These come about concur with those gotten by Kenapar *et al*. (2019).

Table (5): Weed susceptibility as affected by herbicidal combinations at 72 days after planting in 2021 and 2022 seasons.

| Herbicidal combinations | Control (%) and susceptibility a t72 DAP | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *E. crus-ghali* | *E. colonummm* | *D. retroflexa* | *A. auriculata* | *E. alba* | *C. difformis* | *C. rotundus* | Total weeds |
| | Season 2021 | | | | | | | |
| Sitron FL Basagran | 88 MS | 86 MS | 82 MS | 86 MS | 88 MS | 85 MS | 84 MS | 86 MS |
| Sitron FL Inpul | 91 S | 89 MS | 87 MS | 89 MS | 90 MS | 87 MS | 87 MS | 89 MS |
| Nominee FL Inpul | 93 S | 91 S | 91 S | 91 S | 91 S | 90 MS | 91 S | 91 S |
| Nominee FL Basagran | 91 S | 90 MS | 87 MS | 90 MS | 91 S | 90 MS | 90 MS | 90 MS |
| Hand weeding twice | 47 T | 37 T | 30 T | 60 MT | 59 T | 60 MT | 59 T | 53 T |
| Season 2022 | | | | | | | | |
| Sitron FL Basagran | 86 MS | 87 MS | 83 MS | 87 MS | 89 MS | 87 MS | 86 MS | 86 MS |
| Sitron FL Inpul | 89 MS | 90 MS | 87 MS | 88 MS | 89 MS | 86 MS | 77 MT | 87 MS |
| Nominee FL Inpul | 91 S | 93 S | 91 S | 89 MS | 91 S | 90 MS | 86 MS | 91 S |
| Nominee FL Basagran | 89 MS | 90 MS | 89 MS | 88 MS | 91 S | 88 MS | 85 MS | 89 MS |
| Hand weeding twice | 63 MT | 67 MT | 61 MT | 43 T | 49 T | 52 T | 37 T | 55 T |
| | S = > 90 % | | MS = > 80-90 % | | MT = >60-79 % | | T = < 60 % | |
| | Susceptible | | Moderately susceptible | | Moderately Tolerant | | Tolerant | |

### *3.1.3 On yield and its ingredient*

Results in Table (6) revealed that the potential of clover as a precedent winter crop showed a significant increasing on rice plants ingredient and its production in both seasons. In the first season, the increasing values were obtained in plant height by 4.09 cm, number of tillers m$^{-2}$ by 12.22, number of panicle m$^{-2}$ by 18.33, panicle length by 0.72 cm, grain weight panicle$^{-1}$ by 1.05 g, 1000 grain weight by

1.27 g and grain yield by 0.22 ton feddan$^{-1}$ compared to wheat as a precedent winter crop. Whilst the increasing values were obtained in number of tillers m$^{-2}$ by 7.88, number of panicle m$^{-2}$ by 19.7, grain weight panicle$^{-1}$ by 0.46 g, 1000 grain weight by 1.19 and grain yield by 0.18 ton feddan$^{-1}$ compared to wheat as a precedent winter crop, in the another season. These comes about may be due to the legumes *i.e.*, clover in rotation with rice have a large capacity to supply biological nitrogen to the soil (Carlos *et al.*, 2022a), also, the use of legumes increased soil organic carbon and soil phosphorus level (Carlos *et al.*, 2022b).

Table (6): Performance of preceding crops and herbicidal combinations on yield ingredient and grain yield (ton feddan$^{-1}$) in 2021 and 2022 seasons.

| Treatments | Plant height (cm) | Number of tillers (m$^{-2}$) | Number of panicles (m$^{-2}$) | Panicle length (cm) | Grain weight panicle$^{-1}$ (g) | 1000-grain weight (g) | Grain yield (ton feddan$^{-1}$) |
|---|---|---|---|---|---|---|---|
| | 2021 season | | | | | | |
| Preceding crops: | | | | | | | |
| Berseem | 94.09 | 315.60 | 310.23 | 21.72 | 3.36 | 21.99 | 3.27 |
| Wheat | 90.24 | 303.38 | 291.90 | 21.00 | 2.31 | 20.72 | 3.05 |
| LSD $_{0.05}$ | 1.37 | 3.53 | 5..37 | 0.11 | 0.12 | 0.21 | 0.18 |
| Herbicidal combinations | | | | | | | |
| T1. Sitron FL* Basagran | 95.47 | 340.96 | 338.61 | 21.66 | 3.04 | 21.97 | 3.72 |
| T2. Sitron FL Inpul | 93.14 | 333.1 | 326.23 | 21.42 | 2.95 | 21.83 | 3.33 |
| T3. Nominee FL Inpul | 96.14 | 340.21 | 341.47 | 21.72 | 3.07 | 21.92 | 3.68 |
| T4. Nominee FL Basagran | 94.28 | 336.12 | 335.74 | 21.53 | 3.09 | 21.77 | 3.81 |
| T5. Hand weeding twice | 89.28 | 314.52 | 307.34 | 20.82 | 2.77 | 20.73 | 2.56 |
| T6. Untreated check | 86.83 | 189.37 | 165.93 | 19.44 | 2.13 | 19.94 | 1.53 |
| LSD $_{0.05}$ | NS | 12.11 | 15.3 | 0.82 | 0.11 | 0.05 | 0.13 |
| | 2022 season | | | | | | |
| Preceding crops: | | | | | | | |
| Berseem | 90.69 | 304.80 | 308.6 | 21.08 | 2.76 | 22.63 | 3.29 |
| Wheat | 86.58 | 296.92 | 288.9 | 20.80 | 2.30 | 21.44 | 3.11 |
| LSD $_{0.05}$ | NS | 3.21 | 4.62 | NS | 0.12 | 0.18 | NS |
| Herbicidal combinations | | | | | | | |
| T1. Sitron FL Basagran | 91.83 | 334.19 | 334.12 | 21.54 | 3.19 | 23.09 | 3.66 |
| T2. Sitron FL Inpul | 89.3 | 327.41 | 326.28 | 21.21 | 3.02 | 23.12 | 3.71 |
| T3. Nominee FL Inpul | 92.06 | 336.21 | 335.28 | 21.59 | 3.38 | 22.94 | 3.83 |
| T4. Nominee FL Basagran | 90.29 | 329.62 | 331.72 | 21.44 | 3.17 | 22.88 | 3.74 |
| T5. Hand weeding twice | 85.01 | 307.52 | 305.77 | 20.64 | 2.68 | 20.78 | 2.62 |
| T6. Untreated check | 83.48 | 170.23 | 159.97 | 19.24 | 1.73 | 19.52 | 1.69 |
| LSD $_{0.05}$ | 4.72 | 12.14 | 17.61 | 0.54 | 0.34 | 0.26 | 0.24 |

FL = followed by.

Data in Table (6) illustrated that the four herbicidal combinations were increased significantly of rice plant ingredient and its production in both seasons. It is clear that, Nominee at 0.8 L feddan$^{-1}$ FL Inpul at 20 g feddan$^{-1}$ (T3) and Sitron at 2.0 L feddan$^{-1}$ FL Basagran at 1.5 L feddan$^{-1}$ (T1) were superior the other herbicidal combinations for number of tillers m$^{-2}$ by 44.4 and 44.5 % respectively, number of panicles m$^{-2}$ by 51.4 and 51.0% respectively, panicles length by 10.5 and 10.3% respectively, and grain weight panicles$^{-1}$ by 30.6 and 29.9% respectively, in the first season. Meanwhile, the previous respective the two herbicidal combinations gave the highest values of plant height by 9.3 and 9.1% respectively, number of tillers $m^{-2}$ by 49.4 and 49.1% respectively, number of Panicles $m^{-2}$ by 52.3 and 49.1% respectively, Panicles length by 10.9 and 10.7% respectively, and grain weight $Panicles^{-1}$ by 48.8 and 45.8% respectively, compared to untreated check in the second season. Table (6) showed the performance of preceding crops and herbicidal combinations on yield ingredient and grain yield (ton $feddan^{-1}$) in 2021 and 2022 seasons. Furthermore, Nominee at 0.8 L $feddan^{-1}$ FL Basagran at 1.5 L $feddan^{-1}$ (T4), Sitron at 2.0 L $feddan^{-1}$ FL Basagran at 1.5 L $feddan^{-1}$ (T1) and Nominee at 0.8 L $feddan^{-1}$ FL Inpul at 20 g $feddan^{-1}$ (T3) gave the highest increasing values of grain yield by 59.8, 58.9 and 58.4% respectively, compared to untreated check in the first season. Nominee at 0.4 L $feddan^{-1}$ FL Inpul at 20 g $feddan^{-1}$ (T3), Nominee at 0.8 L $feddan^{-1}$ FL Basagran at 1.5 L $feddan^{-1}$ (T4), and Sitron at 2.0 L $feddan^{-1}$ FL Inpul at 20 g $feddan^{-1}$ (T2) gave the highest values of grain yield $feddan^{-1}$ by 55.9, 54.8 and 54.5% respectively, compared to untreated check in the second season. On the other hand, hand weeding twice gave the last increasing values significantly in rice plant ingredient and its production in both seasons. These consequences agree with Kenaper *et al.* (2019).

### *3.2 Effect of interaction between preceding crops and herbicidal combinations*

#### *3.2.1 Dry weight of total weeds (g/m$^2$)*

As appeared from Table (7), the total dry weight of the weeds was lower under untreated check in the interactions between berseem as a precedent winter crop, and herbicidal combinations compared to under untreated check in the interactions between wheat as a precedent winter crop and weed control treatments that is true at 72 and 92 days after planting in both seasons. Concerning, the interactions of berseem as a precedent winter crop and weed control treatments might be organized in a descending agreeing there decreasing the whole dry weight of the weeds as, takes after, Nominee at 0.8 l $feddan^{-1}$ taken after by (FL) Inpul at 20 g $feddan^{-1}$ ($T_3$) by 92.9 and 91.6%, Nominee at 0.8 l $feddan^{-1}$ FL Basagran at 1.5 l $feddan^{-1}$ ($T_4$) by 92.6 and 92.3%, Sitron at 2.0 L $feddan^{-1}$ FL Inpul at 20 g $feddan^{-1}$ ($T_2$) by 90.2 and 89.8%, Sitron at 2.0 L $feddan^{-1}$ FL Basagran at 1.5 L $feddan^{-1}$ ($T_1$) by 88.3 and 87.4% and hand weeding twice ($T_5$) by 62.8 and 60.3% at 72 and 92 DAS separately within the to begin with season. In the second season, the efficiency of the interactions between the two precedent winter crops and herbicidal combinations on reducing the total dry weight of the weeds was confirmed and identical but with minor differences to those observed in the first season. These results compared to the interactions between berseem as a precedent winter crop and untreated cheek. In spite of the interactions between wheat as a point of reference winter crop and herbicidal combinations on reducing significantly the dry weight of the total weeds, were lower than under berseem as mentioned above. However, these interactions are still given a high significantly reduction percentage of the dry w eight of the total weeds with the same arrangement of the interactions under berseem crop. These results concur with those obtained by Tagour *et al.* (2016).

Table (7): Performance of interaction between preceding crops and herbicide combinations on dry weight of total weeds (g/m$^2$) at 72 and 92 days after planting during 2021 and 2022 seasons.

| Preceding crops | Herbicidal combinations | Dry weight of total weeds (g m$^{-1}$) | | | |
|---|---|---|---|---|---|
| | | 2021 season | | 2022 season | |
| | | 72 (DAP) | 92 (DAP) | 72 (DAP) | 92 (DAP) |
| Berseem | T1. Sitron FL Basagran | 46.5 | 56.8 | 41.8 | 61.3 |
| | T2. Sitron FL Inpul | 38.9 | 45.9 | 39.6 | 50.8 |
| | T3. Nominee FL Inpul | 28.3 | 37.6 | 29.8 | 39.6 |
| | T4. Nominee FL Basagran | 29.5 | 34.7 | 39.2 | 42.3 |
| | T5. Hand weeding twice | 147.6 | 178.3 | 155.9 | 203.7 |
| | T6. Untreated check | 339.2 | 401.5 | 334.5 | 425.8 |
| Wheat | T1. Sitron FL Basagran | 54.9 | 71.5 | 57.6 | 68.9 |
| | T2. Sitron FL Inpul | 43.9 | 52.8 | 51.7 | 54.8 |
| | T3. Nominee FL Inpul | 38.6 | 45.8 | 37.8 | 46.2 |
| | T4. Nominee FL Basagran | 42.2 | 46.4 | 42.7 | 49.6 |
| | T5. Hand weeding twice | 192.5 | 203.9 | 171.6 | 234.3 |
| | T6. Untreated check | 396.5 | 449.7 | 392.6 | 491.2 |
| $LSD_{0.05}$ | | 28.01 | 33.96 | 38.39 | 42.72 |

FL = followed by.

### *3.2.2 Yield and its ingredient*

It can be seen in Table (8), the interaction between berseem as a precedent winter crop and herbicidal combinations were increased significantly values of some rice ingredient and its production, compared to the interactions between wheat as a point of reference winter crop and weed control treatments in both seasons. The interactions between berseem as a precedent winter crop and weed control treatments were increased significantly values of grain weight panical$^{-1}$ and 1000 grain weight in a descending order. Nominee at 0.8 L feddan$^{-1}$ FL Inpul at 20 g feddan$^{-1}$ ($T_3$) by 2.02 and 3.35g respectively, Sitron at 2.0 L feddan$^{-1}$ FL Basagran at 1.5 L feddan$^{-1}$ ($T_1$) by 1.97 and 3.49 g respectively Nominee at 0.8 L feddan$^{-1}$ FL Basagran at 1.5 L feddan$^{-1}$ ($T_4$) by 1.93 and 3.07 g respectively, Sitron at 2.0 L feddan$^{-1}$ FL Inpul at 20 g feddan$^{-1}$ ($T_2$) by 1.89 and 3.27 g respectively, and hand weeding twice ($T_5$) by 1.76 and 1.88 g respectively in 2021 season. In the second season, the previous respective interactions gave significant values of grain weight panical$^{-1}$ and 1000 grain weight ($T_3$) by 2.67 and 4.20 g respectively, ($T_1$) 2.53 and 4.55 g respectively, ($T_4$) 2.43 and 4.32 g respectively, ($T_2$) 2.33 and 4.42 g respectively and ($T_5$) 2.03 and 1.96 g, respectively. On other hand, the interactions between berseem as a precedent winter crop and herbicidal combinations for increasing significantly values of grain yield of rice ton feddan$^{-1}$ might be orchestrated in a descending order as follows: ($T_3$) by 2.58 and 2.39 ton feddan$^{-1}$ , ($T_4$) by 2.48 and 2.29 ton feddan$^{-1}$, ($T_2$) by 2.40 and 2.23 ton feddan$^{-1}$, ($T_1$) by 2.34 and 2.16 ton feddan$^{-1}$ and ($T_5$) by 1.14 and 1.19 ton feddan$^{-1}$ these consequence compared to the interactions between berseem as a precedent winter crop and untreated check from wheat in both seasons, respectively. Comparable results were made by Tagour *et al.* (2016).

Table (8): Performance of interaction between preceding crops and herbicidal combinations on yield and its ingredient of rice in 2021 and 2022 seasons.

| Preceding crops | Herbicidal combinations | Grain weight panicle$^{-1}$ (g) | | 1000-grain weight (g) | | Grain yield (ton feddan$^{-1}$) | |
|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | 2021 | 2022 | 2021 | 2022 |
| Berseem | T1. Sitron FL Basagran | 3.56 | 3.72 | 22.75 | 23.87 | 3.75 | 3.69 |
| | T2. Sitron FL Inpul | 3.48 | 3.52 | 22.53 | 23.74 | 3.81 | 3.76 |
| | T3. Nominee FL Inpul | 3.61 | 3.86 | 22.61 | 23.52 | 3.99 | 3.92 |
| | T4. Nominee FL Basagran | 3.52 | 3.62 | 22.33 | 23.64 | 3.89 | 3.82 |
| | T5. Hand weeding twice | 3.35 | 3.22 | 21.14 | 21.28 | 2.55 | 2.72 |
| | T6. Untreated check | 2.67 | 2.26 | 20.53 | 19.71 | 1.58 | 1.85 |
| Wheat | T1. Sitron FL Basagran | 2.51 | 2.66 | 21.18 | 22.31 | 3.69 | 3.62 |
| | T2. Sitron FL Inpul | 2.41 | 2.52 | 21.13 | 22.26 | 3.55 | 3.65 |
| | T3. Nominee FL Inpul | 2.53 | 2.73 | 21.22 | 22.35 | 3.37 | 3.73 |
| | T4. Nominee FL Basagran | 2.47 | 2.58 | 21.2 | 22.12 | 3.72 | 3.66 |
| | T5. Hand weeding twice | 2.23 | 2.13 | 20.32 | 20.27 | 2.56 | 2.51 |
| | T6. Untreated check | 1.59 | 1.19 | 19.26 | 19.32 | 1.41 | 1.53 |
| LSD at 5% | | 0.75 | 0.53 | 0.63 | 0.44 | 0.37 | 0.43 |

FL = followed by.

### *3.2.3 Correlation study*

Information in Table (9) appeared that there was a statistically significant, negative, and extremely high association between the dry weight of broad-leaved and grassy weed species and the grain yield of rice (0.597 and 0.607) than grassy weeds (0.643 and 0.772) seasons 2020 and 2021, individually. This indicates that grassy weeds were more aggressive than broad-leaved weeds in their battle with rice. The maximum negative values for the relationship between the dry weight of total annual weeds and grain yield feddan$^{-1}$ were found to be -0.869* and -0.879* at the 5% level for the two seasons, respectively. The connection between panicles length and grain yield was quite strong and positive (0.589* and 0.576*) in both growing seasons. Therefore, it is accepted that the feature with the most importance and effectiveness for boosting grain output is the grain weight per panicle and 1000 grain weight. Additionally, correlation analysis showed that plant height, panicle length, grain weight per panicle, and 1000-grain weight all positively contributed to the increase in grain output by weed competition. Suggesting that rice grain yield can be influenced strongly by weeds competition and require suitable control program for these weed species to increase rice productivity per unit area.

Table (9): Correlation coefficient between some studied characters and rice grain yield and its ingredient during 2021 and 2022 seasons.

| Characters | Dry weight Grasses & sedges weeds ($gm^{-2}$) | Dry weight of total weeds ($g\ m^{-2}$) | Plant height (cm) | Panicle length (cm) | Grain weight panicle$^{-1}$ (g) | 1000- grain weight (g) | Grain yield (ton feddan$^{-1}$) |
|---|---|---|---|---|---|---|---|
| | 2021 season | | | | | | |
| Dry weight of broad-leaved weeds ($g\ m^{-2}$) | 0.166 | 0.614* | -0.130 | -0.104* | -0.396* | -0.531* | -0.597* |
| Dry weight grasses & sedges weeds ($g\ m^{-2}$) | | 0.812* | -0.158 | -0.213* | -0.515* | -0.611* | -0.643* |
| Dry weight of total weeds ($g\ m^{-2}$) | | | -0.167* | -0.592* | -0.666* | -0.841* | -0.869* |
| Plant height (cm) | | | | -0.062 | -0.136* | -0.278* | -0.201* |
| Panicle length (cm) | | | | | 0.801* | 0.641* | 0.589* |
| Grain weight/ panicle (g) | | | | | | 0.843* | 0.711* |
| 1000- grain weight (g) | | | | | | | 0.836* |
| 2022 season | | | | | | | |
| Dry weight of broad-leaved weeds ($g\ m^{-2}$) | 0.182 | 0.701* | -0.233* | -0.146* | -0.417* | -0.620* | -0.602* |
| Dry weight grasses & sedges weeds ($g\ m^{-2}$) | | 0.841* | -0.364 | -0.357* | -0.601* | -0.645* | -0.772* |
| Dry weight of total weeds ($g\ m^{-2}$) | | | -0.421* | -0.618* | -0.614* | -0.792* | -0.879* |
| Plant height (cm) | | | | -0.134 | -0.242* | -0.351* | -0.209* |
| Panicle length (cm) | | | | | 0.831* | 0.672* | 0.576* |
| Grain weight panicle$^{-1}$ (g) | | | | | | 0.816* | 0.721* |
| 1000- grain weight (g) | | | | | | | 0.801* |

### *3.2.4 Economic feasibility*

Information displayed in Table (10) appeared that profitability was increased berseem crop with (Nominee 0.8 L feddan$^{-1}$ FL Inpul 20 g feddan$^{-1}$) and (Nominee 0.8 L feddan$^{-1}$ FL Basagran 1.5 L feddan$^{-1}$ by (3.19 and 3.07) as compared with wheat crop by (2.63 and 2.85), respectively in 2021 season. On the other side, the interaction between berseem crop and herbicidal combinations on grass income, net come, and profitability were fluctuated but are still superior to hand weeding and less than obtained with wheat crop in both growing seasons. These consequences agree with those obtained by Mamun *et al*. (2013) and Tagour *et al*. (2016).

Table (10): Effect of preceding crops and herbicidal combinations on economic feasibility of rice crop during 2021 and 2022 seasons.

| Preceding crops | Herbicidal combinations | 2021 season | | | | | 2022 season | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total cost (thousand LE feddan$^{-1}$) | Total income (thousand LE feddan$^{-1}$) | Net income (thousand LE feddan$^{-1}$) | Profitability | Benefit / Costs ratio | Total cost (thousand LE feddan$^{-1}$) | Total income (thousand LE feddan$^{-1}$) | Net income (thousand LE feddan$^{-1}$) | Profitability | Benefit / Costs ratio |
| Berseem | Sitron FL Basagran | 8.79 | 26.53 | 17.75 | 2.02 | 3.02 | 11.76 | 35.90 | 24.14 | 2.05 | 3.05 |
| | Sitron FL Inpul | 8.91 | 26.95 | 18.05 | 2.03 | 3.03 | 11..88 | 36.57 | 24.69 | 2.08 | 3.08 |
| | Nominee FL Inpul | 8.84 | 28.18 | 19.34 | 2.19 | 3.19 | 11.81 | 38.08 | 26.26 | 2.22 | 3.22 |
| | Nominee FL Basagran | 8.96 | 27.50 | 18.54 | 2.07 | 3.07 | 11.93 | 37.13 | 25.20 | 2.11 | 3.11 |
| | Hand weeding twice | 10.23 | 18.10 | 7.87 | 0.77 | 1.77 | 13.21 | 26.44 | 13.24 | 1.00 | 2.00 |
| | Untreated check | 7.75 | 11.26 | 3.51 | 0.45 | 1.45 | 10.73 | 17.97 | 7.24 | 0.67 | 1.67 |
| Wheat | Sitron FL Basagran | 9.09 | 26.12 | 17.04 | 1.88 | 2.88 | 12.06 | 35.23 | 23.17 | 1.92 | 2.92 |
| | Sitron FL Inpul | 9.21 | 25.19 | 15.98 | 1.74 | 2.74 | 12.18 | 35.53 | 23.35 | 1.92 | 2.92 |
| | Nominee FL Inpul | 9.14 | 23.98 | 14.85 | 1.63 | 2.63 | 12.11 | 36.28 | 24.17 | 2.00 | 3.00 |
| | Nominee FL Basagran | 9.26 | 26.34 | 17.08 | 1.85 | 2.85 | 12.23 | 35.62 | 23.39 | 1.91 | 2.91 |
| | Hand weeding twice | 10.53 | 18.16 | 7.63 | 0.72 | 1.72 | 13.51 | 24.46 | 10.95 | 0.81 | 1.81 |
| | Untreated check | 8.05 | 10.10 | 2.05 | 0.25 | 1.25 | 11.03 | 14.95 | 3.92 | 0.36 | 1.36 |

## 4. Conclusion

Results of this work revealed that drill-seeded rice may be grown after berseem with a single herbicidal combinations (Nominee at 0.8 L feddan$^{-1}$ FL Enpul at 20 g feddan$^{-1}$ or Nominee at 0.8 L feddan$^{-1}$ FL Basagran at 1.5 L feddan$^{-1}$ or Sitron at 2.0 L feddan$^{-1}$ FL Enpul at 20 g feddan$^{-1}$ or Sitron at 2.0 L feddan$^{-1}$ FL Basagran at 1.5 L feddan$^{-1}$) gave strong weeds control, as well as gave the most prominent values of rice grain yield feddan$^{-1}$ accompanied to the gross income and the profitability in both seasons.

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