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Evaluating the Effects of Different Herbicides and Time of Application on Weed Dynamics and Yield of Rice

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ABSTRACT:

Rice (*Oryza sativa*) is a significant cereal crop that belongs to the Poaceae family and contains water (12%), starch (75-80%), and protein (7.5%).Conventional tilled transplanting, a widely practiced method of rice (*Oryza sativa* L.) establishment in puddled soils in rice–rice systems in Asia, requires a large amount of labor and water, which are becoming scarce and expensive Weed competition is a significant obstacle in reducing DSR yield, but various weed management techniques are available, including cultural, biological, and chemical control. Post-emergence herbicides can be effective in reducing weeds, and an experiment will be conducted at the Agronomic Research Area of the University of Agriculture Faisalabad using the rice cultivar Pusa 1122**.** The treatments will be comprised of two factors. Four herbicides treatments included control), H_1: Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}**,**H_2 : Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 44.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}, H_3: Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} , H_4: Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (pyranix gold, rizabom, LCM) and three application times T_1: 20 DAT, T_2: 30 DAT, T_3: 40 DAT. A randomized complete block design with a factorial arrangement will be used, with a gross plot size of 5 m × 1.8 m. Data on weed dynamics and several rice yield metrics will be collected using established protocols. The data will be subjected to analysis of variance (ANOVA) and LSD at a 5% probability level. The results showed that the lowest weed control (%) was observed where only Cyhalofop-butyl + Metamifop was applied 40 DAT while highest was recorded where Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate was applied 30 DAT. In conclusion it is recommended that Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate is best for weed control in rice at 30 DAT and Cyhalofop-butyl + Metamifop at 20 DAT while all herbicides are least effective at 40 DAT.

Keywords: Rice, Grain yield, Herbicide, Weed control efficiency, weed dynamics.

1. Introduction

Rice constitutes the reproductive structure of the *Oryza sativa* grass species, commonly known as Asian rice, or to a lesser extent, *Oryza glaberrima*, referred to as African rice. This crop holds considerable importance as a primary cereal crop and serves as a fundamental dietary component for approximately 50% of the global populace (Liu et al., 2014). Cultivated across roughly 114 nations, the majority of which belong to developing regions in Asia and Africa. Consequently, any factor posing a threat to yield levels exerts a substantial influence on these economies. In the international rice market, the production for the 2022-23 period experienced a reduction of 2.3 million tonnes, resulting in a total of 512.4 million tonnes (milled basis). Despite the decline, this production level still ranked second only to the record set in the previous year. The primary contributors to this downward revision in production are India, Bangladesh, and the European Union. On the other hand, the projected global consumption and residual use for 2022-23 have undergone a slight increase, reaching a record high of 518.7 million tonnes. As for global ending stocks, it is anticipated that they will amount to 178.5 million tonnes in 2022-23, which is 4.2 million tonnes lower than the previous forecast. This marks the third consecutive year of decline in global ending stocks (United States Department of Agriculture, 2022-23). Rice holds significant economic value as a cash crop, following wheat. Its production is composed 34% fine or basmati types and 66% coarse types. In recent years, there has been a notable increase in the production of coarse hybrid types as farmers allocate more land to their cultivation. Rice contributes approximately in the agricultural sector to the country's GDP. In the 2021-22 period, rice cultivation spanned across 3,537 thousand hectares, reflecting a 6.1 percent increase compared to the previous year's 3,335 thousand hectares. Notably, the production of rice reached a record high marking increase from the previous year's production. Over the past few years, the area allocated to rice cultivation has shown a consistent upward trend (GOP 2021-22). In various agro-ecological regions of Pakistan, diverse strategies for weed management are implemented to address the challenges posed by weeds and enhance crop productivity and profitability (Siddiqi et al., 2014). The adoption of improved cultural practices plays a significant role in conventional weed management. These practices include tight, higher crop densities, utilization of cover crops, intercropping, along with their integration (Moukanni et al., 2022). However, to effectively manage weeds in Pakistan, advanced weed control methods are required. These methods may encompass targeted and site-specific weed control, variable rate soil application of herbicides (particularly when weed growth is patchy and there is spatial variability in seed bank and soil properties), collection of harvest weed seeds, destruction of weed seeds through predation and microbial decay, employment of nano-herbicides, and the adoption of optical spraying technologies. Implementing quarantine measures and legislation can aid in preventing the invasion of alien plant species and enhance the efficacy of existing weed management techniques (Bajwa et al., 2016).

2. Material And Methods

The goal of the trial was to determine how well Metsulfuron Methyl 20% controlled weeds in rice. More details regarding the supplies and techniques used for this experiment are provided under the headings below, which cover the experimental time, site, soil and climate conditions, experimental treatment and design, cultivation of crops, and methods for data collection and analysis.

Description of Site of Experiment

Experiment was run from July to November of 2022.

Location of the Experiment
The University of Agriculture, Faisalabad's Agronomic Research Area will be the site of the study Randomize Complete Block Design under factorial arrangement will be used for layout of experiment, which contain gross plot size of 5 m × 1.8 m. Rice cultivar Pusa 1122 collected from Agriculture field, Ayub research center Faisalabad, will be sown by using sowing method Transplanted rice with seed rate i.e. 8 kg/acre. There will be three replications of each treatment.

Crop Husbandry
Land Preparation
The experimental field was prepared by pulverizing the soil with cultivator followed by the planker, the tractor drawn implements were used for land preparation. Firstly, field was cultivated by the tractor mounted rotavator, containing wheat as a previous crop. After rotavating the previous crop stubbles, nursery of transplanted rice was broadcasted in the field. After a month, the transplanted rice was rotavated in the field. Soil sampling was done in zigzag pattern by auger and will be analyzed from soil laboratory of Ayub agriculture research center. After that, ploughing was carried out twice by cultivator followed by planking for the preparation of required seedbed. The field was than levelled.

Transplanting
Pre-sowing irrigation was applied to the field to prepare the seed bed, and water was given as necessary to maintain soil moisture was maintained near saturation from sowing to milking stage. Seedlings were transplanted in flooded field using two seedling hills at 22.5 cm × 22.5 spacing. Water management in transplanted rice. Water was kept at a depth of 2-3 cm in transplanted rice during the early stages up until seedling establishment. Then, after panicle initiation, a layer of 2-3 cm of water was maintained and was drained 15 days before to plot harvesting. Plots were then continuously flooded and irrigated as needed to maintain a layer of 3-4 cm depth.

Pre-emergence and post-emergence weed management
In transplanting "Council" (Ethoxysulfuron + triafamone) @ 75g/acre was applied to control the woods when the transplantation of rice seedling in the field. Further, three weeding's were done at 20 30 and 40 day after sowing for removing weeds manually.
Following factors and their treatments will be studied:

Treatments:
Factor A: Days after transplant (DAT)
T_1: 20 DAT
T_2: 30 DAT
T_3: 40 DAT
Factor B: Herbicides
H_1: Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}
H_2: Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}
H_3: Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}
H_4: Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}

Statistical Analysis
The gathered data will undergo statistical analysis using Fisher's analysis of variance method, and a LSD (Least Significant Difference) test will be employed to assess distinctions. A

significance level of 5% will be maintained to compare the means of the different treatments (Steel et al., 1997).

3. RESULTS AND DISCUSSION

One of the main issues limiting rice output is weed invasion. The University of Agriculture Faisalabad Agronomic Research Area conducted research on the potential of various herbicide types to enhance the development and yield of rice when applied at various times in summer 2022. Environmental contamination and herbicide resistance in weeds are both caused by using the wrong kinds of herbicides and applying them at the wrong times. Therefore, it is advised that the type of herbicide be chosen in accordance with the types and quantity of weeds as well as the treatment period. The greatest way to lessen the negative effects that weeds have on the rice crop is to use herbicides at the right time. All herbicides function when used at the correct time. This chapter presents the results of the current study, which included data on weed factors, rice growth and yield characteristics, as well as statistical analysis and interpretation. In the experimental area, a variety of weeds were observed, including horse purslane (*Trianthema portulacastrum* L.), goose grass (*Elusine indica (L.) Gaertn.*), crowfoot grass (*Dactyloctenium aeygyptium L. Willd.*), *Asian sprangletop* (L. *chinensis* L.), and bermuda grass (Cynodon dactylon L.). Additionally, sedge species such as *C. rotundus* and rice flat sedge (*Cyperus difformis* L.) were also identified.

Weed Density (M^{-2}) Before Herbicide Application

Weed density is one of the most important factors which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed weed density which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on weed density in rice crop at $p \leq 0.05$ and the interactive effect of herbicide and time was also found significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (58.66 m^{-2}) 20 DAT followed by 40 DAT (54.00m^{-2}) while the lowest was in 30 DAT (58.66 m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{1}+ 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied 20 DAT followed by 40 DAT (52.66 m^{-2})and least was recorded in 20 DAT (42.66 m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (57.66 m^{-2}) 20 DAT followed by 40 DAS (57.00 m^{-2}) while the lowest was in 30 DAT (53.66 m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (53.33 m^{-2}) 40 DAT followed by 20 DAT (50.6 m^{-2}) while the lowest was in 30 DAT (45.00 m^{-2}). The results of interaction of herbicide and time of application showed in Table 4.1 that the minimum weed density (46.66 m^{-2}) was recorded in the plot where cyhalofop-butyl + metamifop was used. Whereas the weed density (46.66 m^{-2}) was recorded in the plot where herbicide was used bispyribic sodium + benosulfuron methyl + alkyl ether sulphate and its time of application was 20 DAT. Results also show that there is increase in weeds infestation where no type of herbicide is used. These results are in line with (Ruzmi et al., 2017) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the maximum weed density which directly linked to the final yield (Pathak et al., 2011). Productive tillers increased by decreased in competition between rice and weeds for the different soil and climatic condition (Bibi et al., 2008) however, Ahmed et al. (2013) also reported that use of herbicide lead to maximum weed density than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	Time of Application of Herbicides			
	20 DAT	30 DAT	40 DAT	Mean
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	58.66 A	50.00 AB	54.00AB	54.22AB
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	46.66 B	47.00 B	52.66 AB	48.77C
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	57.66 A	53.66 AB	57.00 A	56.11A
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	50.66 AB	45.00 B	53.33 AB	49.66BC
Mean	53.41 AB	48.91 B	54.25 A	

Weed density (m^{-2}) after 15 days

Weed density is one of most important factors which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed weed density which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on weed density in rice crop at $p \leq 0.05$ and the combined impact of herbicide application and time was also observed to be statistically significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (58.66 m^{-2}) 20 DAT followed by 40 DAT (54.00 m^{-2}) while the lowest was in 30 DAT (58.66) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1}+ 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied 20 DAT followed by 40 DAT (52.66 m^{-2})and least was recorded in 20 DAT (42.66 m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} ^{1}+ 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (57.66 m^{-2}) 20 DAT followed by 40 DAT (57.00 m^{-2}) while the lowest was in 30 DAT (53.66 m^{-2}).). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml h ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (53.33 m^{-2}) 40 DAT followed by 20 DAT(50.66 m^{-2}) while the lowest was in 30 DAT (45.00). The results of interaction of herbicide and time of application showed in Table that the minimum weed density (21.28 m^{-2}) was recorded in the plot where cyhalofop-butyl + metamifop @ 70.24 ml h ha^{-1} + 46.83 ml ha^{-1} was used. Whereas the weed density (26.53 m^{-2}) was recorded in the plot where herbicide was used bispyribic sodium + benosulfuron methyl + alkyl ether sulphate @4.46 g ha^{-1}+ 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 30 DAT. Results also show that there is increase in weeds infestation where no type of herbicide is used.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	Time of Application of Herbicides			
	20 DAT	30 DAT	40 DAT	Mean
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	40.66 I	41.66 H	51.66 E	44.66 B
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	37.00 K	23.66 O	33.66 I	31.44 F
Cyhalofop-butyl + Metamifop @	31.66 M	28.000	38.00 J	32.55 E

177.84 ml ha^{-1} + 118.56 ml ha^{-1}				
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	28.00 N	43.33 G	53.33 D	41.55 C
Mean	39.66 C	42.16 B	52.27 A	

Weed density (m^{-2}) after 30 days

Weed density is one of the most important factors which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed density which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in table explained the significant effect of types of herbicide and their time of application on weed density in rice crop at $p \leq 0.05$ The combined impact of herbicide application and time was also observed to be statistically significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (28.66 m^{-2}) 20 DAT followed by 40 DAT (28.66 m^{-2}) while the lowest was in 30 DAT (18.66 m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied 30 DAT followed by 40 DAT (33.33 m^{-2})and least was recorded in 20 DAT (28.66 m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (33.00m^{-2}) 40 DAT followed by 20 DAT (26.66 m^{-2}) while the lowest was in 30 DAT (23.00 m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (38.33 m^{-2}) 40 DAT followed by 30 DAT (35.m^{-2}) while the lowest was in 20 DAT (23.00 m^{-2}). The results of interaction of herbicide and time of application showed in Table that the minimum weed density (77.66 m^{-2}) was recorded in the plot where cyhalofop-butyl + metamifop was used. Whereas the weed density (83.66 m^{-2}) was recorded in the plot where herbicide was used bispyribic sodium + benosulfuron methyl + alkyl ether sulphate @4.46 g ha^{-1}+ 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 30 DAT. These results are in line with (Jehangir et al., 2021) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the maximum weed density which directly linked to the final yield (pathak *et al.,* 2011). Productive tillers increased by decreased in competition between rice and weeds for the different soil and climatic condition (Uno et al., 2021) however, Abbas et al. (2021) also reported that use of herbicide lead to maximum weed density than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	28.66 CD	18.66 F	28.66 CD	25.33 B
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	28.66 CD	33.33 B	33.33 B	31.55 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	26.66 DE	23.00 EF	33.00 BC	27.55 B
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	23.00 EF	35.00 AB	38.33 A	32.11 A
Mean	26.58 B	27.50 B	33.33 A	

Weed fresh weight (g m^{-2})

Weed fresh biomass is one of the most important factors which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed fresh biomass which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) explained significant effect of types of herbicide and their time of application on weed fresh weight in rice crop at P≤0.05 and interactive effect of herbicide and time found significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (104.86 g m^{-2}) 20 DAT followed by 40 DAT (82.89 g m^{-2}) while the lowest was in 30 DAT (65.32 g m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1}+ 65.75 ml ha^{-1} was applied highest weed density in 30 DAT (62.31 g m^{-2}) followed by 40 DAT (59.24 g m^{-2})and least was recorded in 20 DAT (42.70 g m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (104.86 g m^{-2}) 40 DAT followed by 20 DAT (49.46 g m^{-2}) while the lowest was in 30 DAT (46.64). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (80.44 g m^{-2}) 30 DAT followed by 40 DAT (77.74 g m^{-2}) while the lowest was in 20 DAT (50.97 g m^{-2}). The results of interaction of herbicide and time of application showed in Table that the minimum weed fresh weight (42.70 g m^{-2}) were recorded in the plot where Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} was used. Whereas the maximum weed fresh biomass (104.86 g m^{-2}) was recorded in the plot where herbicide was used Bispyribic sodium + Benosulfuron methyl+Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1}+ 65.75 ml ha^{-1} and its time of application was 30 DAT. These results are in line with (Singh et al., 2003) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	104.86 A	65.32 ABC	82.89 ABC	84.36 A
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	42.70 C	62.31 ABC	59.24 ABC	69.71 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	49.46 C	46.64 C	104.86A	69.71 A
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	50.97 BC	80.44 ABC	77.74 ABC	69.71 A
Mean	61.99A	63.67A	81.002A	

Weed fresh weight (g m^{-2}) after 15 days

Weed fresh weight is one of the most important factors which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed fresh weight which reduced cost of production and increased final yield. Analysis of variance (ANOVA) explained significant effect of types of herbicide and their time of application on weed fresh biomass in rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (49.33 g m^{-2}) 40 DAT followed by 30 DAT (30.83 g m^{-2}) while the lowest was in 20 DAT (25.70 g m^{-2}) where

Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 40 DAT (64.40 g m^{-2}) followed by 30 DAT (43.26 g m^{-2})and least was recorded in 20 DAT (24.33 g m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (53.76 g m^{-2}) 40 DAT followed by 30 DAS (34 g m^{-2}) while the lowest was in 20 DAT (26.50 g m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (69.33 g m^{-2}) 40 DAT followed by 30 DAT (52.33 g m^{-2}) while the lowest was in 20 DAT (24.85 g m^{-2}). The results of interaction of herbicide and time of application showed in Table that the minimum weed fresh biomass (24.33 g m^{-2}) were recorded in the plot where Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} was used. Whereas the maximum weed fresh biomass (69.33 g m^{-2}) was recorded in the plot where herbicide was used Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 30 DAT. These results are in line with (Singh et al., 2003) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	25.70 EF	30.83 DE	49.33 B	35.28 C
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	24.33 F	43.26 C	64.40 A	44.00 B
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	26.50 EF	34.00 D	53.76 B	38.08 C
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	24.33 F	52.33 B	69.33 A	48.18 A
Mean	24.85 C	59.20 A	59.20 A	

Weed fresh weight (g m^{-2}) after 30 days

Weed fresh weight is one of the most important factor which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed fresh biomass which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) explained significant effect of types of herbicide and their time of application on weed fresh weight in rice crop at $P \leq 0.05$ and interactive effect of herbicide and time found significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (69.00 g m^{-2}) 40 DAT followed by 30 DAT (51.60 g m^{-2}) while the lowest was in 20 DAT (26.06 g m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 40 DAT (84.66 g m^{-2}) followed by 30 DAT (63.70 g m^{-2})and least was recorded in 20 DAT (48.13 g m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (84.66 g m^{-2}) 40 DAT followed by 30 DAT (54 g m^{-2}) while the lowest was in 20 DAT (44.20 g m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (88.66 g m^{-2}) 40 DAT followed by 30 DAT (60.00 g m^{-2}) while the lowest was in 20 DAT (40 g m^{-2}). The results of interaction of herbicide and time of application showed in Table that the minimum weed

fresh biomass (26.06 g m^{-2}) were recorded in the plot where Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} was used. Whereas the maximum weed fresh biomass (88.66 g m^{-2}) was recorded in the plot where Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} herbicide was used and its time of application was 40 DAT. These results are in line with (Singh et al., 2003) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	26.06 I	51.60 EF	69.00 C	48.88 C
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	48.13 FG	63.70 D	84.66 A	65.50 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	44.20 GH	54.63 E	84.66 A	57.50 B
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	41.60 H	70.06 BC	88.66 A	24.33 F
Mean	40.00 C	60.00 B	48.88 A	

Weed dry weight (g m^{-2})

Weed dry weight is one of the most important factor which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed dry biomass which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on weed fresh biomass in rice crop at $P \leq 0.05$ and the interactive effect of herbicide and time was also found significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (29.71 g m^{-2}) 20 DAT followed by 40 DAT (29.21 g m^{-2}) while the lowest was in 30 DAT (11.44 g m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{1} was applied highest weed density in 30 DAT (21.19 g m^{-2}) followed by 40 DAT (16.97 g m^{-2})and least was recorded in 20 DAT (11.11 g m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (29.21 g m^{-2}) 40 DAT followed by 30 DAT (13 g m^{-2}) while the lowest was in 20 DAT (13.53 g m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} ^{1}+ 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (21.19 g m^{-2}) 30 DAT followed by 40 DAT (16.61 g m^{-2}) while the lowest was in 20 DAT (15.01 g m^{-2}). The results of interaction of herbicide and time of application showed in Table that the minimun weed fresh biomass (26.06 g m^{-2}) were recorded in the plot where Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} was used. Whereas the maximum weed fresh biomass (88.66 g m^{-2}) was recorded in the plot where Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} ^{1}+ 46.83 ml ha^{-1} herbicide was used and its time of application was 40 DAT. These results are in line with (Singh et al., 2003) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	Time of Application of Herbicides			
	20 DAT	30 DAT	40 DAT	Mean
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	29.71 A	11.44 C	29.21 AB	21.02 A
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} 29.64 g ha^{-1} + 65.75 ml ha^{-1}	11.11 C	21.19 ABC	16.97 ABC	15.46 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	13.53 C	13.53 C	29.21 AB	18.35 A
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	15.01 C	21.19 ABC	16.61 BC	18.35 A
Mean	17.34 A	15.81 A	21.17 A	

Weed dry weight (g m^{-2}) after 15 days

Weed dry weights one of the most important factor which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed dry biomass which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on weed fresh biomass in rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (19.43 g m^{-2}) 40 DAT followed by 20 DAT (13.06 g m^{-2}) while the lowest was in 30 DAT (12.70 g m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 40 DAT (28.03 g m^{-2}) followed by 30 DAT (17.63 g m^{-2})and least was recorded in 20 DAT (11.06 g m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (22.63 g m^{-2}) 40 DAT followed by 30 DAT (13 g m^{-2}) while the lowest was in 20 DAT (10.70 g m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (26.00 g m^{-2}) 40 DAT followed by 30 DAT (21.56 g m^{-2}) while the lowest was in 20 DAT (10.83 g m^{-2}). The results of interaction of herbicide and time of application showed in Table that the minimum weed dry biomass (10.70 g m^{-2}) were recorded in the plot where Cyhalofop-butyl + metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} was used. Whereas the maximum weed fresh biomass (28.03 g m^{-2}) was recorded in the plot where herbicide was used Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 40 DAT. These results are in line with (Bhattacharjee *et al.,* 2002) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	Time of Application of Herbicides			
	20 DAT	30 DAT	40 DAT	Mean
Bispyribic sodium + Benosulfuron	13.06 E	12.70 E	19.43 CD	15.06 B

methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}				
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	11.06 E	17.63 D	28.03 A	18.91 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	10.70 E	13.53 E	22.63 BC	15.62 B
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	10.83 E	21.56 CD	26.00 AB	19.46 A
Mean	11.41 C	16.35 B	24.02 A	

Weed dry biomass (g m^{-2}) after 30 days

Weed dry biomass is one of the most important factor which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce weed dry biomass which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) explained the significant effect of types of herbicide and their time of application on weed fresh biomass in rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (28.89 g m^{-2}) 40 DAT followed by 30 DAT (18.56 g m^{-2}) while the lowest was in 20 DAT (15.56 g m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1}+ 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 40 DAT (29.00 g m^{-2}) followed by 30 DAT (25.33 g m^{-2})and least was recorded in 20 DAT (14.13 g m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (24.66 g m^{-2}) 40 DAT followed by 30 DAT (24 g m^{-2}) while the lowest was in 20 DAT (19.60 g m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (30.83 g m^{-2}) 30 DAT followed by 40 DAT (30.33 g m^{-2}) while the lowest was in 20 DAT (17.66 g m^{-2}). The results of interaction of herbicide and time of application showed in Table that the minimun weed dry biomass (15.56 g m^{-2}) were recorded in the plot where Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} was used. Whereas the maximum weed fresh biomass (30.74 g m^{-2}) was recorded in the plot where Cyhalofop-butyl + Metamifop 177.84 ml ha^{-1} + 118.56 ml ha^{-1} herbicide was used and its time of application was 30 DAT. These results are in line with (Bhattacharjee et al., 2002) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	15.56 EF	18.56 D	28.89 A	21.90 B
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 gha^{1}+ 29.64 g ha^{-1} + 65.75 ml ha^{-1}	14.13 F	25.33 C	29.00 B	22.82 B
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	19.60 D	24.23 C	24.66 C	22.83 B
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	17.66 DE	30.83 AB	30.33 AB	26.27 A

Mean	16.74 C	24.74 B	28.89 A	

Plant height (cm)

Plant height is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can change the Plant height which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on Plant height of rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. The results of interaction of herbicide and time of application showed in Table that the maximum Plant height (134.00 cm) were recorded in the plot where Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} herbicide was used. Whereas the maximum plant hight (111.67 cm) were recorded in the plot where Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} and its time of application was 20 DAT. Whereas the minimum panicle length (114.33 cm) were recorded in the plot where no herbicide was used and weed crop competition remained till the harvesting. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (132.33 cm) 20 DAT followed by 40 DAT (129.67 cm) while the lowest was in 30 DAT (114.67 cm) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 30 DAT (134.33 cm) followed by 40 DAT (128.00 cm)and least was recorded in 20 DAT (126.00 cm). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (134.00 cm) 40 DAT followed by 30 DAT (127.33 cm) while the lowest was in 20 DAT (111.67 cm). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (137.00 cm) 30 DAT followed by 20 DAT (117.67 cm) while the lowest was in 20 DAT (115.33 cm). These results are in line with (Reddy et al., 2003) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the optimum plant height which directly linked to the final yield (Walia *et al.*, (2008). However, Singh et al. (2018) also reported that use of herbicide at different time led to direct impact on plant height.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	132.33 ABC	114.67 EF	129.67 BCD	125.56 A
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	126.00 D	134.33 AB	128.00 CD	129.44 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	111.67 F	127.33 CD	134.00 AB	124.33 B
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	117.67 E	137.00 A	115.33 EF	123.33 B
Mean	121.92 B	128.33 A	126.75 A	

Productive Tiller (m^{-2})

Productive tiller is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can enhance the productive tillers which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on productive tillers of rice crop at $P \leq 0.05$ and the interactive effect of herbicide and time was also found significant. The results of interaction of herbicide and time of application showed in Table that the maximum number of productive tillers (334 m^{-2}) were recorded in the plot where herbicide was used Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 30 DAT. Whereas the minimum number of productive tillers 198 were produced in the plot where Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} were used. The number of productive tillers increased by decreased in competition between rice and weeds for the different soil and climatic condition (Kumar and Ladha, 2011).However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (334.00 m^{-2}) 30 DAT followed by 40 DAT (276.33 m^{-2}) while the lowest was in 30 DAT (269.00 m^{-2}) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 20 DAT (366.67 m^{-2}) followed by 30 DAT (320.67 m^{-2})and least was recorded in 40 DAT (273.67 m^{-2}). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (287.67 m^{-2}) 40 DAT followed by 30 DAS (264.00 m^{-2}) while the lowest was in 20 DAT (198.00 m^{-2}). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} LCM) the highest weed density was recorded (315.67 m^{-2}) 20 DAT followed by 30 DAT (307.33 m^{-2}) while the lowest was in 40 DAT (252.33 m^{-2}). These results are in line with (Singh *et al.*, 2015) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the maximum number of tillers which directly linked to the final yield (Chauhan 2012) However, Mahajan et al. (2013) also reported that use of herbicide lead to maximum number of tillers than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	269.00 EF	334.00AB	276.33DEF	293.11B
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	366.67 A	320.67BC	273.67DEF	320.33A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	198.00 G	264.00EF	287.67CDE	238.11C
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	315.67 BC	307.33BCD	252.33 F	303.56AB
Mean	287.33 B	306.50 A	272.50 B	

Non-Productive Tiller

Nonproductive tillers is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can reduce the non-productive tillers which reduced cost of production and increased the final yield.

Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on non-productive tillers of rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. The results of interaction of herbicide and time of application showed in Table that the minimum number of non-productive tillers (224.33 m^{-1}) were recorded in the plot where there is use of any type of herbicide. Whereas the maximum non-productive tillers (473.67 m^{-1}) were recorded in the plot where herbicide Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1}+ 118.56 ml ha^{-1} was used and its time of application was 20 DAT .However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1}+ 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (415.33) 20 DAT followed by 40 DAT (389.33) while the lowest was in 30 DAT (388.67) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1}+ 29.64 g ha^{-1}+ 65.75 ml ha^{-1} was applied highest weed density in 30 DAT (425.33) followed by 40 DAT (345.00)and least was recorded in 20 DAT (238.00). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1}+ 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (360.00) 40 DAT followed by 20 DAT (347.33) while the lowest was in 30 DAT (224.33). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1}+ 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (473.67) 20 DAT followed by 40 DAT (323.33) while the lowest was in 30 DAT (255.00). Results also show that there is increase in weeds infestation where no type of herbicide is used. These results are in line with (Singh et al., 2018) stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the maximum number of tillers which directly linked to the final yield (Chauhanm, 2012) However, Mahajan et al. (2013) also reported that use of herbicide lead to maximum number of tillers than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	415.33 B	388.67 BC	389.33 BC	397.78A
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	238.00D	425.33 AB	345.00C	336.11 B
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	347.33C	224.33D	360.00 C	310.56 B
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	473.67 A	255.00D	385.00BC	371.22 A
Mean	368.58A	323.33B	369.83 A	

Panicle length (cm)

Panicle length is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can enhance the panicle length which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on panicle length of rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. The results of interaction of herbicide and time of application showed in Table that the maximum panicle length (18.94 cm) was recorded in the plot where any herbicide was used. Whereas the minimum panicle length (14.77 cm) was

recorded in the plot where Cyhalofop-butyl+ Metamifop @ 177.84 ml ha^{-1}+ 118.56 ml ha^{-1} was used. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic Sodium + Benosulfuron methyl @ 33.34 g har¹ + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (19.22 cm) 30 DAT followed by 20 DAT (14.793) while the lowest was in 40 DAT (13.13cm) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha¹+ 29.64 g ha^{-1}+ 65.75 ml ha^{-1} was applied highest weed density in 30 DAT (15.45 cm) followed by 20 DAT (15.45 cm)and least was recorded in 40 DAT (14.44 cm). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1}+ 118.56 ml ha (Herbi) applicaton the highest weed density was recorded (18.94 cm) 20 DAT followed by 40 DAT (17.93 cm) while the lowest was in 20 DAT (18.94 cm). While by the application of Cyhalofop-butyl+ Metamifop @ 70.24 ml ha^{-1}+ 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (18.94 cm) 20 DAT followed by 30 DAT (16.95 cm) while the lowest was in 40 DAT (15.60 cm). Results also show that there is increase in these results are in line with (Makino et al., 2022) stated that interaction between panicle length where herbicide is used. herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the maximum panicle length which directly linked to the final yield (Panda et al., 2020). However, Huang et al. (2021) also reported that use of herbicide leads to maximum panicle length than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	14.79 EF	19.22 A	13.13 F	15.71 B
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	15.45 DE	15.45 DE	14.44 EF	15.32 B
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	18.94 AB	14.77 EF	17.93 ABC	17.21 A
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	18.94 AB	16.95 BCD	15.60 A	17.16 A
Mean	17.19 A	16.60 A	15.27 B	

Number of grains per panicle

Number of grains per panicle is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can enhance the number of grains per panicle which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on number of grains per panicle of rice crop at $P \leq 0.05$ and the interactive effect of herbicide and time was also found significant. The results of interaction of herbicide and time of application showed in Table that the minimum number of grains per panicle (58.00) were recorded in the plot where herbicide was used Bispyribic Sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} and its time of application was 20 DAT. Whereas the maximum number of grains per panicle (87.66) were recorded in the plot where Cyhalofop-Butyl + Metamifop was used. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic Sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (79.66) 30 DAT followed by 40 DAT (65.66) while the lowest was in 20 DAT (58.00) where Bispyribic sodium+ Benosulfuron methyl + Alkyl ether sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 20 DAT

(77.333) followed by 30 DAT (74.333) and least was recorded in 40 DAT (58.333). In the application of Cyhalofop-Butyl + Metamifop @ 177.84 ml ha¹+ 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (85.66) 30 DAT followed by 40 DAT (77.66) while the lowest was in 20 DAT (62.33). While by the application of Cyhalofop-Butyl+ Metamifop @ 70.24 ml ha^{-1}+ 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (87.66) 30 DAT followed by 40 DAT (74.66) while the lowest was in 40 DAT (62.33). These results are in line with (Lu et al., 2022). Stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the maximum number of grains per panicle which directly linked to the final yield (Nath et al., 2021). Number of grains per panicle increased by decreased in competition between rice and weeds for the different soil and climatic condition Mai et al. (2021). However, (Gunasekaran et al., 2023) also reported that use of herbicide produces maximum Paddy yield than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Treatments Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	58.00 H	79.66 C	65.667 F	67.77 C
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	77.33 D	74.33 E	58.33 H	70.00 B
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	62.33 G	85.66 B	77.66 D	75.22 A
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	62.33 G	87.66 A	74.66 E	74.88 A
Mean	65.00 C	81.83 A	69.08 B	

1000 Grain weight (g)

1000 Grain weight is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can enhance the 1000 Grain weight which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on 1000 Grain weight of rice crop at $P \leq 0.05$ and the interactive effect of herbicide and time was also found significant. The results of interaction of herbicide and time of application showed in Table that the maximum 1000 Grain weight (21.42 g) were recorded in the plot where herbicide was used Bispyribic Sodium + Benosulfuron Methyl + Alkyl ether Sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 40 DAT. Whereas the minimum 1000 Grain weight (18.81) were recorded in the plot where no any herbicide was used and weed crop competition was remained till the harvesting. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic Sodium + Benosulfuron Methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (21.42 g) 30 DAT followed by 20 DAT (21.14 g) while the lowest was in 40 DAT (21.11 g) where Bispyribic Sodium+ Benosulfuron Methyl + Alkyl ether Sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 30 DAT (20.88 g) followed by 20 DAT (20.72 g) and least was recorded in 40 DAT (20.54 g). In the application of Cyhalofop-Butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (22.27 g) 20 DAT followed by 30 DAT (21.54 g) while the lowest was in 40 DAT (19.59 g). While by the application of Cyhalofop-Butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density

was recorded (22.47 g) 20 DAT followed by 40 DAT (20.39 g) while the lowest was in 30 DAT (19.67 g). These results are in line with (Mahajan et al., 2012), Stated that interaction between herbicide and time of application resulted that by using the herbicide at its proper time we can achieve the maximum 1000 Grain weight which directly linked to the final yield (Ruan et al., 2020). 1000 Grain weight increased by decreased in competition between rice and weeds for the different soil and climatic condition Chauhan et al. (2014). However, Zhao et al. (2020) also reported that use of herbicide produces maximum Paddy yield than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	21.14 BCD	21.42 ABCD	21.11 BCD	21.22 A
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	20.72 CDE	20.88 CD	20.54 CDE	20.71 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	22.27 AB	21.54 ABC	19.59 E	21.13 A
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{1}	22.47 A	19.67 E	20.33 DE	20.82 A
Mean	21.65 A	20.88 B	20.39 B	

Biological Yield

Biological yield is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can enhance the biological yield which reduced cost of production and increased the final yield. Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on biological yield which of rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. The results of interaction of herbicide and time of application showed in Table that the maximum biological yield which (19.12 t ha^{-1}) were recorded in the plot where herbicide was used Bispyribic Sodium + Benosulfuron Methyl + Alkyl ether Sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 40 DTS. Whereas the minimum biological yield (6.50 t ha^{-1}) was recorded in the plot where no herbicide was used and weed crop competition had remained till the harvesting. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic Sodium + Benosulfuron Methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (19.36 t ha^{-1}) 30 DAT followed by 20 DAT (15.74 t ha^{-1}) while the lowest was in 40 DAT (13.43 t ha^{-1}) where Bispyribic Sodium+ Benosulfuron Methyl + Alkyl ether Sulphate @4.46 g ha^{1}+ 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 40 DAT (20.43 t ha^{-1}) followed by 20 DAT (16.32 t ha^{-1}) and least was recorded in 30 DAT (12.52 t ha^{-1}). In the application of Cyhalofop-Butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha (Herbi) applicaton the highest weed density was recorded (18.74 t ha^{-1}) 20 DAT followed by 30 DAT (17.05 t ha^{-1}) while the lowest was in 40 DAT (11.45 t ha^{-1}). While by the application of Cyhalofop-Butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (21.41 t ha^{-1}) 40 DAT followed by 20 DAS (17.52 t ha^{-1}) while the lowest was in 30 DAT (12.92 t ha^{-1}). These results are in line with

(Fakharzadeh et al., 2020). stated that interaction between herbicide and time of application resulted in the fact that by using the herbicide at its proper time we can achieve the maximum biological yield which directly linked to the final yield (Guo et al., 2020). Biological yield increased by decreased in competition between rice and weeds for the different soil and climatic condition (Kostylev et al., 2019). However, (Kumarathilaka et al., 2020) also reported that use of herbicide produces maximum biological yield than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	**Time of Application of Herbicides**			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	15.74 F	19.36 BC	13.43 G	16.18 B
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	16.32 EF	12.52 GH	20.43 AB	16.42 AB
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	18.74 CD	17.05 EF	11.45 H	15.75 B
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	17.52 DE	12.92 GH	21.41 A	15.46 B
Mean	17.08 A	15.46 B	16.68 A	

Paddy yield (t ha^{-1})

Paddy yield stands out as one of the most crucial characteristics. Which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can enhance the Paddy yield. This resulted in lowered production costs and an enhanced final yield**.** Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on productive tillers of rice crop at P≤0.05 and the interactive effect of herbicide and time was also found significant. Table presents the outcomes of the interaction between herbicide application and timing, revealing that the highest paddy yield (5.15 t ha^{-1}) was documented. in the plot where herbicide was used Bispyribic Sodium + Benosulfuron Methyl + Alkyl ether Sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 40 DAT. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic Sodium + Benosulfuron Methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest paddy yield was recorded (5.083 t ha^{-1}) 30 DAT followed by 40 DAT (4.4 t ha^{-1}) while the lowest was in 20 DAT (3.620 t ha^{-1}) where Bispyribic Sodium+ Benosulfuron Methyl + Alkyl ether Sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest paddy yield in 20 DAT (4.86 t ha^{-1}) followed by 30 DAT (4.05 t ha^{-1}) and least was recorded in 40 DAT (3.90 t ha^{-1}). In the application of Cyhalofop-Butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest paddy yield was recorded (4.63 t ha^{-1}) 30 DAT followed by 40 DAT (4.0 t ha^{-1}) while the lowest was in 20 DAT (3.33). While by the application of Cyhalofop-Butyl + Metamifop @ 70.24 ml ha^{-1}+ 46.83 ml ha^{-1} (LCM) the highest paddy yeild was recorded (4.58 t ha^{-1}) 40 DAT followed by 20 DAT (3.73 t ha^{-1}) while the lowest was in 30 DAT (3.32 t ha^{-1}). These results are in line with (Wang et al., 2021). stated that interaction between herbicide and time of application resulted in the herbicide at its proper time we can achieve the maximum Paddy yield which directly linked to the final yield (Wu et al., 2022). Paddy yield increased by decreased in competition between rice and weeds for the different soil and climatic condition (Qin et al., 2023).

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	Time of Application of Herbicides			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	3.62 DE	5.08 A	4.40 ABCD	4.36A
Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	4.86 AB	4.05 BCDE	3.90 CDE	4.27 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	3.33 E	4.63 ABC	4.04 BCDE	4.00 A
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	3.73 CDE	3.32 E	4.58 ABC	3.87 A
Mean	3.88 A	4.271 A	4.23 A	

Harvest Index

Harvest Index is one of the most important traits which has direct link with the final yield of rice crop. By alter the types of herbicide and their time of application we can enhance the harvest index. This led to a decrease in production costs and an increase in the final yield**.** Analysis of variance (ANOVA) presented in Table explained the significant effect of types of herbicide and their time of application on harvest index which of rice crop at P≤0.05. The combined impact of herbicide application and time was also observed to be statistically significant. The results of interaction of herbicide and time of application showed in Table that the maximum harvest index which (33%) were recorded in the plot where herbicide was used Bispyribic Sodium + Benosulfuron Methyl + Alkyl either Sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} and its time of application was 40 DAT. Whereas the minimum harvest index (24%) were recorded in the plot where no any herbicide was used and weed crop competition was remained till the harvesting. However, interaction among time of application and herbicide treatments showed highest weed density recorded of Bispyribic Sodium + Benosulfuron Methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1} (Rizabom) highest weed density was recorded (39.66 %) 20 DAT followed by 40 DAT (36.33 %) while the lowest was in 20 DAT (36.66%) where Bispyribic Sodium+ Benosulfuron Methyl + Alkyl ether Sulphate @4.46 g ha^{-1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1} was applied highest weed density in 30 DAT (38.66 %) followed by 40 DAT (36.66 %) and least was recorded in 20 DAT (37.33 %). In the application of Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1} (Herbi) applicaton the highest weed density was recorded (38.00 %) 40 DAT followed by 30 DAT (37.00 %) while the lowest was in 20 DAT (34.00 %). While by the application of Cyhalofop-Butyl+ Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1} (LCM) the highest weed density was recorded (36.00 %) 20 DAT followed by 30 DAT (34.66 %) while the lowest was in 40 DAT (29.00 %). These results are in line with (Chen et al., 2021). stated that interaction between herbicide and time of application resulted in the fact that by using the herbicide at its proper time we can achieve the maximum harvest index which directly linked to the final yield (Nakano et al., 2020). Harvest index increased by decreased in competition between rice and weeds for the different soil and climatic condition (Zhang et al., 2021). However, (Yan et al., 2022) also reported that use of herbicide produces maximum harvest index than without use of herbicide.

INDIVIDUAL COMPARISON OF TREATMENT MEANS

Types of Herbicides	Time of Application of Herbicides			
	20 DAT	**30 DAT**	**40 DAT**	**Mean**
Bispyribic sodium + Benosulfuron methyl @ 33.34 g ha^{-1} + 22.23 g ha^{-1}	39.66 A	36.66 A	36.33 A	37.55 A

Bispyribic sodium + Benosulfuron methyl + Alkyl ether sulphate @ 4.46 g ha^{1} + 29.64 g ha^{-1} + 65.75 ml ha^{-1}	37.33 A	38.66 A	36.66 A	37.55 A
Cyhalofop-butyl + Metamifop @ 177.84 ml ha^{-1} + 118.56 ml ha^{-1}	34.00 AB	37.00 A	38.00 A	36.33 AB
Cyhalofop-butyl + Metamifop @ 70.24 ml ha^{-1} + 46.83 ml ha^{-1}	36.00 A	34.66 AB	29.00 B	33.22 B
Mean	36.75 A	36.75 A	35.00 A	

4. Conclusion

The findings indicated that the transplanting approach produced the lowest weed density and fresh and dry weight of weeds. Results for the number of branches, number of pods, number of grains per panicle, harvest index, and biological yield for the plant, plant height, biological yield, 1000-grain weight and straw yield showed that among sowing methods, the highest value was observed in transplanted rice. Among weed control practices pre-emergence herbicide application is better with flat line sowing method than hand hoeing and weedy check plots.

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