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Weed Competition and Determination of the Critical Weed Control Period for Irrigated Rice in the Senegal River Valley

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Abstract **Original Research Article**

Weeds are one of the main factors limiting the productivity of irrigated rice in the Senegal River Valley. The objective of this study was to determine the critical period of weed competition in order to optimize the weed control schedule. The trials were conducted in 2026 and 2017 at an experimental station (ISRA/Fanaye) and on farmers' fields, using a completely randomized Fisher block design with 16 treatments and three replications. The treatments combined different durations of cover cropping, weed-free maintenance, and weed control practices. The parameters evaluated included rice and weed biomass, plant height, number of panicles, thousand-grain weight, and yield. The results show that extending the cover crop period significantly increases weed biomass and reduces rice growth and agronomic performance. Plots kept free of weeds exhibited the highest biomass, the greatest number of panicles, and the best yields, while the weedy control plots recorded the lowest values. Thousand-grain weight was minimally affected by the treatments, unlike yield, which decreased sharply due to weed competition. The critical period shows that during the hot dry season, weeds must be controlled between 12 and 48 days after emergence (DAE), whereas during the rainy season this period ranges from 24 to 48 DAE. Prolonged competition can result in losses exceeding 70%. These results demonstrate that early weed control and maintaining a weed-free crop until approximately 48 DAE are essential strategies for maximizing the yield of irrigated rice in the Senegal River Valley.

Keywords: Irrigated rice, Critical period, Weed control, Senegal River Valley.

INTRODUCTION

In sub-Saharan Africa, yield losses in rice due to weeds are estimated at least 2.2 million metric tons per year (Rodenburg *et al.,* 2009; Rodenburg *et al.,* 2019). If left uncontrolled, weeds pose a constant threat to crop productivity through competition for nutrients, space, and light, as well as through harmful effects that reduce both the quality and quantity of the harvest (Halford *et al.,* 2001; Kavaliauskaite *et al.,* 2006; Saha *et al.,* 2021).

In the Sahel, yield losses due to weeds are the main cause of low yields in no-till farming (Diallo *et al.,* 1997), and there is considerable room for improvement in weed management.

In the Senegal River Valley, weed management in direct seeding is more critical than in transplanting. In direct seeding, weeds can emerge at the same time as or before the rice seedlings, posing a serious competition problem (Johnson *et al.,* 2004). The concept of critical periods of weed competition during which weeds have the greatest impact on crop growth has been validated by (Nieto *et al.,* 1968; Hall *et al.,* 1992; Noba, 2002; Mbaye, 2013; Bassène, 2014).

Such research can provide guidelines for optimizing management to avoid maximum competition between crops and weeds, and enable farmers to make more judicious use of resources to control weeds (Johnson *et al.,* 2004).

MATERIAL AND METHODS

Study area description

The study was conducted in the Senegal River Valley, which covers approximately 34% of the country's territory and extends from the river's mouth to the Malian border. In accordance with the subdivision proposed by Poussin (2008), the study area specifically covers the Delta and the Middle Valley, two major regions characterized by intense agricultural activity and a high population density. The three regions along the river (Saint-Louis, Matam, and Tambacounda) had a combined population of 3.021.223 in 2023, representing nearly 16.7% of Senegal's population (ANSD, 2024).

The trials were conducted in the Middle Senegal River Valley during the rainy and dry seasons of 2016 and 2017. The experiments were conducted under controlled conditions at the experimental station of the Senegalese Institute for Agricultural Research (ISRA) in Fanaye and under farmer-managed conditions in four basins (Bokhol, Gaé, Razel, and Thiangaye).

The study was conducted in various types of hydro-agricultural systems in the Senegal River Valley, notably Large-Scale Irrigation Systems (GA), Village Irrigation Perimeters (PIV), and Private Irrigation Perimeters (PIP). These systems differ in terms of their land area and the level of irrigation and drainage infrastructure. The soils in the study area consist mainly of Chromic vertisols (hollaldes, faux-hollaldes) and Eutric fluvisols (fondés).

Plant Material

The plant material is the Sahel 134 rice variety (IR 31851-96-2-3-2-1), selected for its short growing cycle (less than 110 days) and well-suited to both the hot off-season and the winter growing season.

Methods

The Experimental design

The trial was conducted using a completely randomized Fisher-block experimental design with 16 treatments in 3 replicates. For each growing season, one block was located at a controlled station and the second in a farm setting. Each plot had an area of 15.4 m² (7 m x 2.2 m). The total number of plots was 16 × 3 = 48. The distance between the basic plots and between replicates was 30 cm, and the distance between blocks was 1 m. The total area of the trial was 884.53 m² (44.9 m × 19.7 m), or 0.088 ha. The experimental block was demarcated by a 1-meter border.

Treatments studied

The experiment, conducted at the research station and on plots on commercial farms, includes three treatment series:

5 cover crop treatments (H1, H2, H3, H4, H5) in which the field is kept weed-free at the beginning for a variable period of time and then allowed to grow weeds until harvest.

- H1: kept weed-free for the first 12 growing days, then allowed to grow weeds until harvest.
- H2: kept weed-free for the first 24 growing days, then allowed to grow weeds until harvest.
- H3: kept weed-free for the first 36 growing days, then allowed to grow weeds until harvest.
- H4: kept weed-free for the first 48 growing days, then allowed to grow weeds until harvest.
- H5: kept weed-free for the first 60 growing days, then allowed to grow weeds until harvest.
- TP: Weed-free treatment maintained weed-free until harvest

5 weed control treatments (B1, B2, B3, B4, B5) in which the crop is allowed to grow with weeds initially for a variable period of time and then kept weed-free until harvest.

- B1: Weeds allowed to grow between emergence and the 12th day, then kept weed-free until harvest.
- B2: Weeds allowed to grow between emergence and the 24th day, then kept weed-free until harvest.
- B3: Weeds allowed to grow between emergence and the 36th day, then kept weed-free until harvest.
- B4: Weeded between emergence and the 48th day and kept weed-free until harvest.
- B5: Weeded between emergence and the 60th day and kept weed-free until harvest.
- TE: Weeded control plot left weeded until harvest.

4 agricultural treatment plots (P1, P2, P3, P4) in which successive weedings are carried out on different dates.

- P1: 2 weedings on the 12th and 48th days.
- P2: 2 weedings on the 24th and 36th days.
- P3: 3 weedings on the 12th, 48th, and 60th days.
- P4: 3 weedings on the 24th, 36th, and 48th days.

Weed control treatments (Bi) and cover crop treatments (Hi), as well as clean control plots (TP) and cover crop control plots (TE), make it possible to determine the date and critical period of weed competition (Niéto *et al.,* 1968).

The critical period of competition is defined as the growth period of the crop that must occur in the absence of weeds in order to prevent measurable and unacceptable yield losses (Hall *et al.,* 1992; Knezevic *et al.,* 2002).

The critical period of competition represents the time interval between two distinct components of crop-weed competition. The first is the maximum weed-infested period, which corresponds to the maximum duration of weed presence that a crop can tolerate early in the season before suffering inevitable yield losses. The second is the critical weed control period, which corresponds to the minimum duration of weed control required from crop emergence to prevent unacceptable yield losses (Knezevic *et al.,* 2002).

In principle, weed control before or after the critical competition period does not contribute to improving the crop's potential yield.

Agricultural practices (Pi), in addition to certain weed control and cover cropping treatments, make it possible to establish a weed control schedule tailored to rice cultivation (Caussanel *et al.,* 1986).

Measurements and Observations

The following observations and measurements are conducted on:

- Weeds: Weeds are allowed to grow freely from emergence until a certain leaf stage, at which point they are removed. This removal is done manually.
  - ✓ When a rice plot reaches the weeding stage (12 DAP), data-t-on weed identification and dry biomass are recorded in tables.
  - ✓ Two 0.25 m² quadrats are used to sample the weed community in each experimental plot.
  - ✓ The quadrat is placed in the center of the plot in an area that is relatively representative of the entire plot to avoid edge effects.
  - ✓ The samples are then placed in paper bags to dry in the sun before being placed in an oven at 105°C for 1 hour.
  - ✓ Each bag is then weighed to determine the dry biomass of each species group in each plot.

- Rice: The same methods for sampling vegetative biomass are used for rice. Plant height, the number of panicles per square meter, and the weight of 1000 grains were assessed at rice maturity.

The harvest was conducted over an area of 8 m² in each test plot to determine yield. Yield is calculated based on the number of grains per square meter (NG) and the weight of 1000 grains (PMG), divided by the area of the yield square (SCR). In our study, we calculated production, which is defined as the number of paddy grains harvested per unit area. This yield is reported at a moisture content of 14%.

Statistical Analyses

The statistical test used was a two-factor analysis of variance for yield and yield components. Means were compared using the Newman-Keuls test. The software used was R version 3.4.0.

RESULTS

Soil Characteristics

The physicochemical characteristics of the soils show significant variability among the study sites (Table 1). Two main soil types were identified: Eutric Fluvisols (Fanaye, Razel, and Thiangaye), which have a relatively sandy texture, and Chromic Vertisols (Bokhol and Gaé), which are more clayey, particularly in Gaé, where the clay content reaches 67.5%. This textural diversity influences the soils' water and nutrient retention capacities.

Chemically, the pH ranges from 5.06 to 7.29, indicating slightly acidic to neutral soils, while electrical conductivity remains generally low, suggesting low salinity. The highest levels of carbon, nitrogen, and organic matter are observed in Gaé, indicating greater fertility, whereas Thiangaye has the lowest values. The C/N ratio ranges from 7.18 to 18.25, suggesting varying rates of organic matter mineralization across sites.

Differences in hydro-agricultural infrastructure may also contribute to this variability. Bokhol, Gaé, and Razel have modern irrigated areas with drainage systems, unlike Fanaye and Thiangaye, which are characterized by rudimentary infrastructure without drainage systems. These differences in soil texture, fertility, and water management are likely to influence rice growth as well as the diversity of weed communities in rice fields.

Table 1: Physical and chemical characteristics of soils at the test sites

	Location				
Parameters	**Fanaye**	**Bokhol**	**Gaé**	**Razel**	**Thiangaye**
Soil type	Eutric fluvisols	Chromic vertisols	Chromic vertisols	Eutric fluvisols	Eutric fluvisols
Local soil name	Fondé	Faux-Hollaldé	Hollaldé	Fondé	Fondé
Clay (%)	24.5	34.5	67.5	26.5	27.5
Silt (%)	16.75	30.25	8	20.25	22
Sand (%)	58.75	35.25	24.5	53.25	50.5
pH	6.42	5.32	5.06	5.39	7.29
Electrical conductivity CE (µs.cm-1)	93.2	386	90.6	300	80.5
Organic carbon (%)	0.529	0.825	1.658	0.921	0.313
Total nitrogen (%)	0.064	0.083	0.112	0.05	0.044
C/N ratio	8.306	9.941	14.852	18.25	7.179
Organic matter (%)	0.911	1.419	2.852	1.585	0.539
Irrigation scheme characteristics	Small village irrigation schemes, poorly	Electrically powered pumping station, irrigation	Electrically powered pumping station, irrigation	Electrically powered pumping station,	Small village irrigation schemes, poorly

	designed and leveled, with inadequate bunds, frequent flooding and no drainage system.	canal network, and a hierarchical drainage system.	canal network, and a hierarchical drainage system.	irrigation canal network, and a hierarchical drainage system.	designed and leveled, with inadequate bunds, frequent flooding and no drainage system.

Effect of treatments on the dry biomass of rice and weeds

The treatments significantly affected rice biomass and weed biomass during the two years of the study (Table 2). In 2016, the highest rice biomass was obtained with the clean control (TP), at 764 g during the hot dry season and 788 g during the winter season, while the lowest values were recorded with the weeded control (TE) (363 g and 494 g, respectively). Treatments H4 and H5 also produced high rice biomasses ranging from 668 g to 754 g during the hot dry season. Conversely, as the duration of cover cropping increased from B1 to B5, rice biomass gradually decreased from 699 g to 416 g during the hot dry season.

Regarding weeds, the lowest biomasses were observed with B1 (1.2 g) and B2 (6.2 g) during the 2016 hot dry season, while the weeded control had the highest biomass at 245.3 g. In 2017, the same pattern was observed, with weed biomass of only 3.6 g under B1 compared to 203.2 g for the weeded control (TE). These results show that early weed control significantly reduces weed growth and promotes rice biomass accumulation.

Table 2: Effects of treatments by site and season on the dry biomass of rice and weeds

Treatment	2016				2017			
	Rice dry biomass(g)		Weed dry biomass(g)		Rice dry biomass(g)		Weed dry biomass(g)	
	DS	WS	DS	WS	DS	WS	DS	WS
B1	699^{abc}	778^{a}	1.2^{i}	2.0^{g}	318^{abcd}	279^{ab}	3.6^{e}	1.1^{f}
B2	596^{cde}	697^{ab}	6.2^{i}	37.1^{f}	286^{abcdef}	236^{abc}	10.1^{e}	22.7^{ef}
B3	543^{efg}	616^{ab}	22.5^{hi}	80.2^{e}	259^{bcdef}	227^{abc}	40.8^{de}	64.7^{d}
B4	467^{ghi}	552^{b}	56.0^{fg}	182.3^{c}	217^{def}	211^{bc}	127.1^{c}	116.4^{c}
B5	416^{hi}	543^{b}	113.0^{de}	227.3^{b}	208^{ef}	192^{c}	171.5^{b}	160.1^{ab}
H1	371^{i}	544^{b}	150.5^{bc}	222.6^{b}	224^{cdef}	177^{c}	129.7^{c}	138.6^{bc}
H2	468^{ghi}	590^{ab}	97.9^{e}	181.1^{c}	302^{abcde}	224^{abc}	61.7^{d}	55.7^{de}
H3	602^{cde}	681^{ab}	67.8^{f}	117.0^{d}	317^{abcd}	285^{ab}	39.8^{de}	51.0^{de}
H4	754^{a}	675^{ab}	50.4^{fgh}	81.4^{e}	313^{abcd}	293^{a}	34.4^{de}	45.4^{de}
H5	668^{abcd}	594^{ab}	28.7^{ghi}	72.7^{e}	332^{ab}	301^{a}	33.4^{de}	32.1^{de}
P1	487^{fgh}	541^{b}	134.3^{cd}	210.4^{b}	267^{bcdef}	224^{abc}	67.3^{d}	50.0^{de}
P2	572^{def}	623^{ab}	176.5^{b}	169.6^{c}	302^{abcde}	230^{abc}	57.4^{d}	40.5^{de}
P3	633^{bcde}	658^{ab}	155.3^{bc}	131.2^{d}	308^{abcd}	222^{abc}	33.6^{de}	40.0^{de}
P4	729^{ab}	697^{ab}	108.4^{de}	114.1^{d}	322^{abc}	283^{ab}	31.7^{de}	48.7d^{e}
TE	363^{i}	494^{b}	245.3^{a}	257.8^{a}	199^{f}	169^{c}	203.2^{a}	171.4^{a}
TP	764^{a}	788^{a}	-	-	379.8^{a}	300^{a}	-	-
Mean	571.3	629.9	88.4	130.5	285.1	241.3	65.4	65
CV (%)	11.8	17.1	24.7	14.1	18.5	17	35.7	32.4
F-value	22.9***	3.8***	64.3***	116.2***	5.6***	6.8***	40.1***	37.8***

DS= Dry season ; WS= Wet season

Effect of treatments on the height and number of panicles per square meter of rice

Plant height was significantly affected by the treatments (Table 3). In 2016, the clean control (TP) recorded the greatest heights, at 57.2 cm during the hot dry season and 60.0 cm during the rainy season. The grassed control (TE), on the other hand, had the lowest values at 38.3 cm and 51.6 cm. Plant height decreased gradually from 55.6 cm (B1) to 42.3 cm (B5) as the initial grassing period increased.

The number of panicles followed the same trend. In 2016, the clean control (TP) produced 617 panicles/m² during the hot dry season, compared to only 400 panicles/m² for the grassed control. In 2017, values ranged from 512 panicles/m² under TP to 380 panicles/m² under TE. The H5 and P4 treatments yielded results similar to those of the bare control, with 543 and 562 panicles/m² in 2016, respectively, and 507 and 503 panicles/m² in 2017. These results indicate that effective weed control promotes tillering and panicle formation.

Table 3: Effects of treatments by location and season on rice plant height and the number of panicles per square meter

Treatment	2016				2017			
	Rice plant height (cm)		Nombre of panicules/m^{-2}		Rice plant height (cm)		Nombre of panicules/m^{-2}	
	DS	WS	DS	WS	DS	WS	DS	WS
B1	55.6a	60.0a	569^{b}	190^{bcd}	63.8a	61.5ab	501^{ab}	456^{a}

B2	53.2b	58.8b	545^{bc}	180^{cde}	63.1ab	60.7cd	489^{ab}	450^{a}
B3	49.0c	58.2b	518^{cd}	173^{def}	62.3c	60.3de	462^{cd}	415^{abc}
B4	46.3d	55.3cd	481^{e}	164^{ef}	60.8de	59.2f	445de	400^{bcd}
B5	42.3e	54.5de	453^{f}	155^{fg}	59.5g	57.9g	429^{e}	341^{ef}
H1	39.3f	51.1g	406^{gh}	147^{g}	57.9i	56.6h	392^{f}	310^{f}
H2	41.5e	51.2g	432^{fg}	166^{ef}	58.8h	58.4g	422^{e}	343^{ef}
H3	42.7e	53.7ef	502de	181^{cde}	59.7fg	59.6f	446de	384^{cd}
H4	46.4d	56.2c	523^{cd}	197^{bc}	61.2d	60.9bc	480^{bc}	423^{ab}
H5	52.7b	59.2ab	543^{bc}	203^{ab}	62.5bc	61.7ab	507^{ab}	439^{ab}
P1	43.1e	52.8f	411^{gh}	172^{def}	60.4def	59.4f	418^{e}	381^{cd}
P2	46.7d	54.7de	426^{gh}	176de	60.7de	59.8ef	460^{cd}	383^{cd}
P3	45.6d	53.4f	413^{gh}	169^{ef}	60.0efg	59.1f	433^{e}	365de
P4	52.7b	58.8b	562^{b}	214^{a}	62.1c	61.4ab	503^{ab}	434^{ab}
TE	38.3f	51.6g	400^{h}	147^{g}	57.9i	56.1h	380^{f}	306^{f}
TP	57.2a	60.0a	617^{a}	215^{a}	63.6a	62.1a	512^{a}	450^{a}
Mean	47.1	55.6	487	178	60.9	59.7	455	392
CV (%)	3.3	1.3	3.7	6.4	0.9	0.8	3.8	6.1
F-value	85.1***	106.9***	86.2***	20.8***	72.6***	78.1***	34.6***	24.9***

DS= Dry season ; WS= Wet season

Effect of treatments on 1000 grain weight and yield

The thousand-kernel weight was relatively unaffected by the treatments (Table 4). The values ranged from 21.7 g to 23.0 g in 2016 and from 21.3 g to 23.0 g in 2017. The clean control (TP) recorded the highest weights at 23.0 g, while the weeded control (TE) had the lowest values at 21.7 g in 2016 and 21.3 g in 2017.

In contrast, the differences in yield were very significant. In 2016, the highest yield was achieved by the bare control (TP), with yields of 8.6 t/ha during the hot dry season and 6.5 t/ha during the rainy season, compared to only 2.6 t/ha and 1.8 t/ha for the grassed control. Treatments H4, H5, and P4 achieved high yields ranging from 7.8 to 8.1 t/ha during the hot dry season, which were statistically comparable to the bare control.

Treatments B1, H4, H5, and P4 delivered the best agronomic performance, with high biomass, more than 500 panicles/m², and yields that could exceed 9 t/ha, while the weeded control consistently showed the lowest values, confirming the major negative impact of weeds on rice productivity.

Table 4: Effects of treatments by site and season on 1000-grain weight and grain yield

Treatment	2016				2017			
	1000-grain weight (g)		Grain yield (t ha⁻¹)		1000-grain weight (g)		Grain yield (t ha⁻¹)	
	DS	WS	DS	WS	DS	WS	DS	WS
B1	22.8^{a}	22.8^{ab}	8.2^{a}	6.1^{a}	22.9^{ab}	22.9^{ab}	9.6^{a}	5.4^{a}
B2	22.8^{a}	22.7^{ab}	6.9^{b}	6.1^{a}	22.8^{abc}	22.7^{abcd}	8.1^{b}	5.1^{a}
B3	22.7^{a}	22.6^{ab}	6.1^{cd}	5.2^{b}	22.8^{abc}	22.6^{abcd}	7.8^{b}	3.9^{cd}
B4	22.6^{ab}	22.5^{b}	5.2^{de}	4.7^{bc}	22.7^{bcd}	22.4^{cde}	6.8^{c}	3.7^{cd}
B5	22.3^{ab}	22.3^{b}	5.0^{e}	4.1^{c}	22.4^{d}	22.2^{e}	5.9^{c}	2.4^{e}
H1	22.0^{bc}	21.9^{c}	3.4^{f}	3.3^{d}	21.8^{e}	21.6^{f}	4.3^{d}	3.2^{d}
H2	22.8^{a}	22.3^{b}	5.6^{cde}	4.1^{c}	22.4^{d}	22.5^{bcde}	4.9^{d}	3.3^{d}
H3	22.8^{a}	22.7^{ab}	5.6^{cde}	5.0^{b}	22.8^{abc}	22.8^{abcd}	6.7^{c}	4.2^{bc}
H4	22.9^{a}	22.8^{ab}	7.8^{a}	6.0^{a}	22.8^{abc}	22.9^{abc}	8.9^{a}	5.3^{a}
H5	22.9^{a}	22.8^{ab}	8.1^{a}	6.2^{a}	22.9^{ab}	22.9^{ab}	9.2^{a}	5.2^{a}
P1	22.4^{ab}	22.7^{ab}	6.2^{bc}	4.5^{bc}	22.4^{d}	22.3^{de}	6.0^{c}	3.8^{cd}
P2	22.6^{ab}	22.6^{ab}	6.8^{b}	5.2^{b}	22.6^{cd}	22.5^{bcde}	6.4^{c}	4.3^{bc}
P3	22.5^{ab}	22.4^{b}	5.9^{cde}	4.8^{bc}	22.5^{d}	22.3^{de}	6.0^{c}	3.6^{cd}
P4	22.9^{a}	22.8^{ab}	7.85^{a}	6^{a}	22.8^{abc}	22.8^{abcd}	7.6^{b}	4.8^{ab}
TE	21.7^{c}	21.7^{c}	2.6^{g}	1.8^{e}	21.7^{e}	21.3^{g}	2.2^{e}	1.4^{f}
TP	23.0^{a}	23.0^{a}	8.6^{a}	6.5^{a}	23^{a}	23.0^{a}	9.7^{a}	5.6^{a}
Mean	22.6	22.5	6.3	5	22.6	22.5	6.9	4.1
CV (%)	1.6	1.2	8.3	10.4	0.7	1.1	9.6	12.9
F-value	5.2***	9.6***	63.2***	33.3***	30.1***	21.9***	56.7***	29.0***

DS= Dry season ; WS= Wet season

Determining the critical period of weed competition with rice

• Critical period during the hot dry season

Figure 1 shows that rice yield gradually decreases when weeds compete with the crop (WI), while it increases when the field is kept weed-free (WC). The early weed competition threshold (EWCT) is observed around 12 days after emergence (DAE), indicating that weeds begin to significantly affect yield starting at this point. The late weed-free threshold (LWFT) falls between 45 and 48 DAE, beyond which the presence of new weeds has little effect on yield.

Thus, for yield losses of 10%, the critical period of weed competition generally extends from 12 to 48 DAE. Keeping the crop free of weeds during this period is essential to preserve yield potential, whereas prolonged competition can result in losses exceeding 70%. These results underscore the importance of performing weed control operations before 12 days after emergence (DAE) and keeping the field weed-free until approximately 48 DAE.

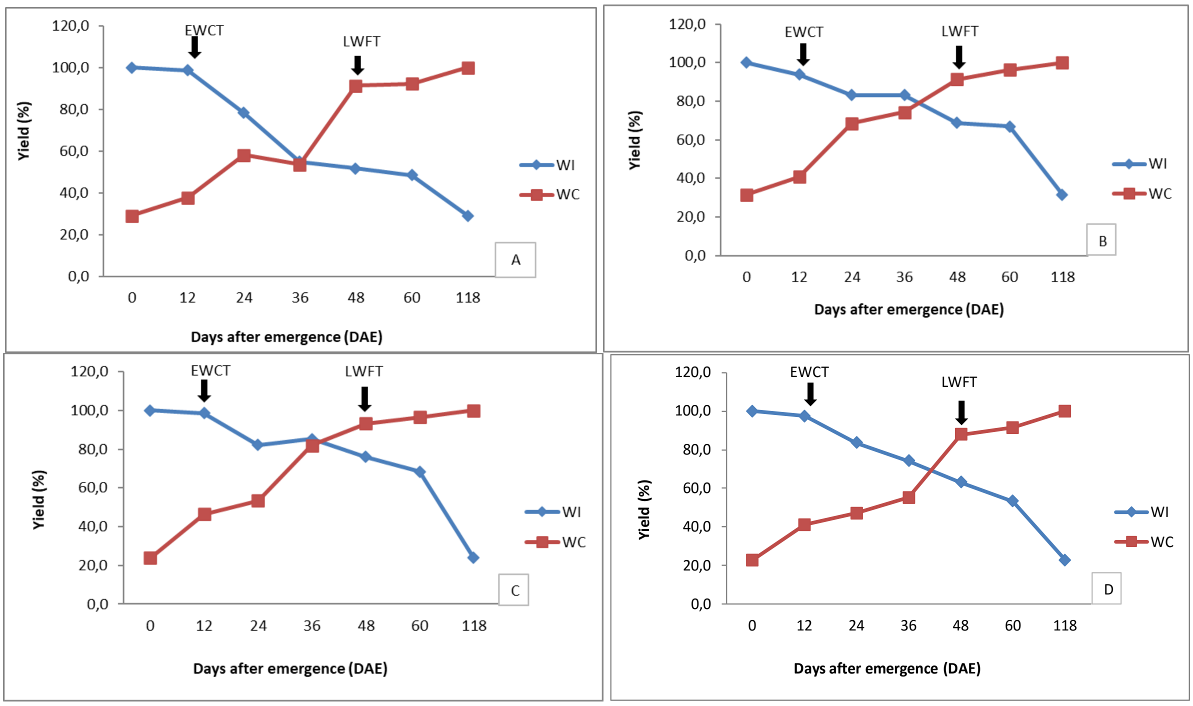

Figure 1: Critical period of competition during the hot dry season

EWCT= Early weed competition threshold ; LWFT=Late weed-free threshold ; WI=Weed Infestation ; WC=Weed Control

- **Critical Period During the Rainy Season**

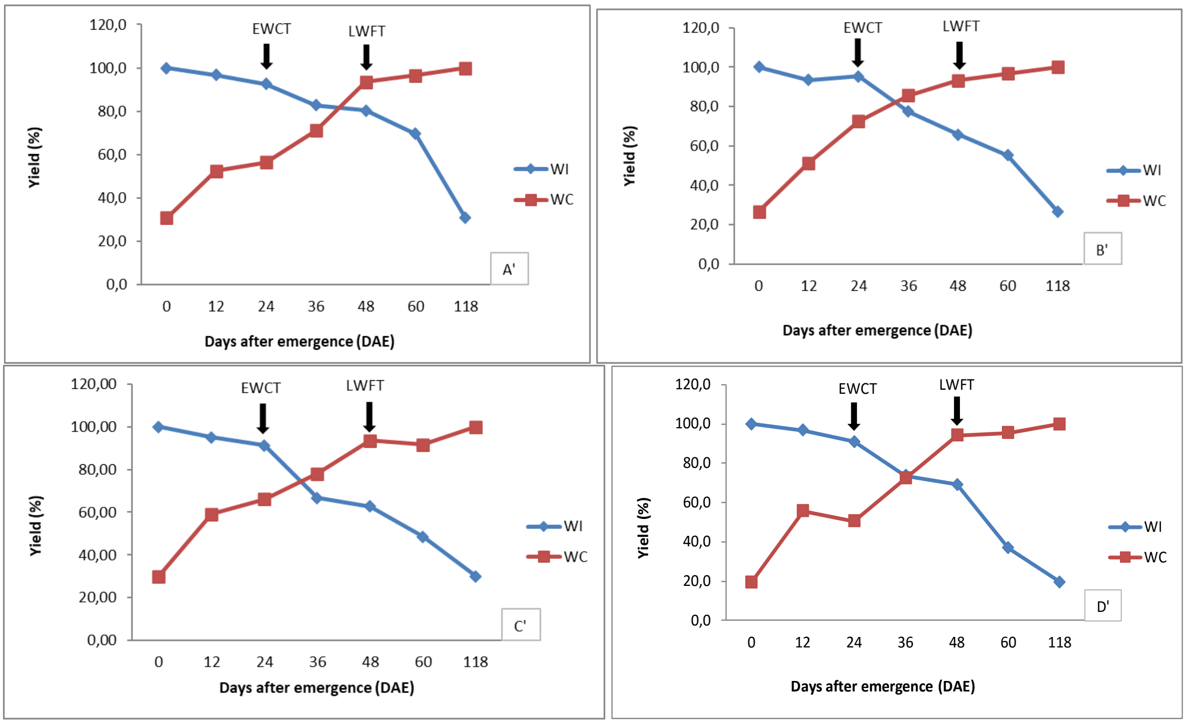

Figure 2: Critical period of competition during the wintering season

EWCT= Early weed competition threshold ; LWFT=Late weed-free threshold ; WI=Weed Infestation ; WC=Weed Control

Figure 2 shows that, during the rainy season, rice yield decreases as the duration of coexistence with weeds (WI) increases, while it improves when the crop is kept weed-free (WC). The early weed competition threshold (EWCT) is reached between 24 and 30 days after emergence (DAE), indicating that beyond this period, weeds exert sufficient competition to significantly reduce yield. The late weed-free threshold (LWFT) is around 48 DAE; beyond this point, the presence of new weed emergence no longer significantly affects yield.

Consequently, for yield losses of 10%, the critical period of weed competition generally extends from 24 to 48 DAE. Keeping the crop free of weeds during this window is crucial for limiting yield losses and ensuring optimal production. These results underscore the importance of taking action before 24 DAE and keeping the field weed-free until approximately 48 DAE during the overwintering period.

DISCUSSIONS

These results indicate that weed competition increases as the duration of cover cropping in the plots increases, resulting in significant dry biomass production. Weeds have negative effects on rice biomass regardless of treatment or date (Johnson *et al.,* 2004). Prolonged cover cropping has a negative impact on rice yield and yield components, particularly in the weeded control and treatments similar to this weeded control. These results are consistent with the studies by (Noba, 2002 ; Mbaye, 2013), which indicate that weed growth hinders crop growth, as yield components such as the number of panicles, the number of spikes, and the 1000-grain weight are lower in the weeded control plots and higher in the gradual weeding (H) treatments and in the clean control plots.

In other words, the lowest dry weight of weeds was recorded in plots that remained weed-free for more than 45 days during the growing season (Micheal *et al.,* 2013). Our results also corroborate those of Uprety (2005), which indicate that the best tillers, large panicles, and high rice yields are obtained with early weed control. Early weeding promotes good development during the vegetative phase of rice, particularly in terms of tillering. Sylla et al. (2017) reported that the highest number of tillers was obtained with the clean control. Furthermore, the results of Bouet et al. (2016) showed that rice cultivation practices influence panicle production. The effect of the treatments on rice plant height was significant, and the greatest heights were observed in the clean control (TP) and in the treatments that remained clean for increasingly longer periods (H5, H4, H3).

These results are consistent with the findings of Bouet et al. (2016), which showed a significant difference between the height of rice plants measured under the intensive rice cultivation system and that observed on the smallholder plot. Indeed, there are periods during which weeds must be removed because they are harmful, and others during which they may be allowed to grow because their effects on the crop are minimal (King, 1951; Nieto, 1960, 1968; Mbaye, 2013) or even beneficial.

Yields are higher in plots that are kept increasingly weed-free, whether during the hot dry season or the rainy season, while yields are much lower in heavily weeded plots. These results are comparable to those of Anwar et al. (2012). Grain yield increased as the period free of weeds lengthened, up to 6 weeks after rice sowing. The same trends were observed when rice plants were infested for more than 60 days during growth, the reduction in yield was approximately 66 to 83%. In contrast, plots that remained weed-free for more than 45 days during their life cycle produced significantly higher grain yields (Micheal *et al.,* 2013).

The results of the experiments show that yield losses increase with the duration of weed growth, depending on whether the growing season is hot and dry or wet. For any crop, there is a critical period of weed competition beyond which the crop remains susceptible (Akobundu & Poku, 1987; Bassène, 2014). During the first few weeks after rice emergence, resources are generally sufficient to support the growth of both the crop and weeds (Norsworthy *et al.,* 2004; Mbaye, 2013). Thus, it is important to note that there is no single critical weeding period that applies to all environments for a given crop, but identifying such a period helps farmers choose the appropriate method for weed control (Noba, 2002; Bassène, 2014). Under our conditions, the critical period during the hot dry season falls between the 12th DAE (3-leaf stage) and the 48th DAE (90% tillering). In contrast, during the wet season, this critical period ranges from the 24th DAE (onset of tillering) to the 48th DAE (90% tillering). These results are consistent with those of Touré et al. (2013), who identified the critical period of weed competition in rice as between the 14th and 42nd day after sowing for the NERICA and WAB 56-104 varieties, and between 28 and 42 days after sowing for the CG 14 variety.

CONCLUSION

This study highlights the significant impact of weed competition on the growth and yield of irrigated rice in the Senegal River Valley. Extending the duration of weed growth leads to an increase in weed biomass and a significant reduction in rice biomass, the number of panicles, and yield, while the thousand-grain weight is largely unaffected. The best agronomic results were obtained in plots kept weed-free or weeded early, confirming the importance of early weed management.

Determination of the critical competition period shows that during the hot dry season, the crop must be kept weed-free between 12 and 48 days after emergence

(DAE), whereas during the winter season, this period extends from 24 to 48 DAE. Beyond these thresholds, weed competition causes yield losses that can exceed 70%.

These results provide technical guidelines for developing weed control schedules that are implemented at the optimal time, thereby reducing unnecessary interventions, making better use of the resources allocated to weed control, and sustainably improving the productivity of irrigated rice.

REFERENCES

- Agence Nationale de la Statistique et de la Démographie (ANSD). 2024. Rapport définitif du cinquième Recensement général de la Population et de l'Habitat (RGPH-5, 2023) : État et structure, urbanisation et caractéristiques socioculturelles de la population. Dakar, Sénégal : ANSD, 177 p.
- Akobundu I. O. et Poku J. A,. 1987.Weed control in soybean in the tropics: research, production and utilisation. John Wiley and Sons Ltd, Chishester. pp: 69-77.
- Anwar M. P., Juraimi A. S., Samedani B., Puteh A., and Man A., 2012. Critical period of weed control in aerobic rice. The ScientificWorld Journal, ID 603043, 10 p.
- Bassène C. 2014. La flore adventice dans les cultures de maïs (Zea mays L.) dans le sud du Bassin Arachidier : structure, nuisibilité et mise au point d'un itinéraire de désherbage. Thèse de Doctorat Unique. Université Ckeikh Anta Diop de Dakar. 184 p.
- Bouet A., Bahan F., Boka A., Esmel M. and Keli J., 2016. Performance agronomique du Système de Riziculture Intensive (SRI) en Côte d'Ivoire. Asian Journal of Science and Technology, 7 (8) : 3447-3451.
- Caussanel J.P & Kafiz B., 1986. Une méthode de détermination des seuils de nuisibilité d'une espèce adventce dans une céréale (Avena sp x Ble de printemps). Proc. Ewrs symposium, Economic weed contro. pp. 83-90.
- Diallo S., Johnson D.E., 1997. Les adventices du riz irrigué au Sahel et leur contrôle, in : Miézan, K.M., Wopereis, M.C.S., Dingkuhn, M., Deckers, J., Randolph, T.F. (Eds.), Irrigated rice in the Sahel : prospects for sustainable development. WARDA, Dakar, pp. 311-323.
- Hall, M.R., Swanton C.J., et Anderson G.W., 1992. The critical period of weed control in grain corn (Zea mays). Weed Science 40:441-447.
- Halford C., Hamill A.S., Zhang J., & Doucet C., 2001. Critical period of weed control in no-till soybean (Glycine max) and corn (Zea mays). Weed Technology 15:737-744.
- Johnson D.E., Wopereis M.C.S., Mbodj D., Diallo S., Powers S., Haefele S.M., 2004. Timing of weed management and yield losses due to weeds in integrated rice in the Sahel. Field Crop Research 85: 31-42.
- Kavaliauskaite, D., Bobinas, C., 2006. Determination of weed competition critical period in red beet. 16 Agron. Res. 4: 217-220.
- King F.C., 1951. The weed problem. A new approach. London United Kingdom. Faber and Faber Ltd. Printed by Latimer Trend & Co. Ltd., Plymouth. 191p.
- Knezevic, S.Z., Evans S.P., Blankenship E.E., Van Acker R.C., et Lindquist J.L., 2002. Critical period for weed control: the concept and data analysis. Weed Science 50:773-786.
- Mbaye M., S. 2013. Association mil [Pennisetum glaucum (L.) R.Br] et niébé [Vigna unguiculata (L.) Walp.] : Arrangement spatiotemporel des cultures, structures, dynamique et concurrence de la flore adventice et proposition d'un itinéraire technique. Thèse de Doctorat d'état. Université Ckeikh Anta Diop de Dakar. 236 p.
- Micheal JSAS., Juraimi AS., Selamat A., Man A., Anwar Mp., & Uddin MK., 2013. Critical period of weed control in aerobic rice system. AJCS. 7(5) : 665-673.
- Nieto J., 1960. Elimine las hierbas a tiempo. Agricultura técnica en México. Invierno 1959-1960 (9) 16-19.
- Niéto J.H., Brondon M. A. & Gonzales J.T., 1968. Critical periods of the crop growth cycle for competition from weeds. Pans 14, 159-166.
- Noba K., 2002. La flore adventice dans le sud du Bassin arachidier (Sénégal): structure, dynamique et impact sur la production du mil et de l'arachide. Thèse de Doctorat d'Etat de Biologie Végétale. Option Malherbologie, FST, UCAD, Dakar. 158 p.
- Norsworthy J.K. & Oliveira M.J., 2004. Comparison of the critical period for weed control in wide- and narrow-row corn. Weed Science. 52: 802–807.
- Rodenburg, J., Johnson, J. -M., Dieng, I., Senthilkumar, K., Vandamme, E., Akakpo, C., Allarangaye, M. D., Baggie, I., Bakare, S. O., Bam, R. K., Bassoro, I., Abera, B. B., Cisse, M., Dogbe, W., Gbakatchetche, H., Jaiteh, F., Kajiru, G. J., Kalisa, A., and Saito, K. 2019. Status quo of chemical weed control in rice in sub-Saharan Africa. Food Security, 11(1), 69–92.
- Rodenburg, J., Saito, K., Kakai, R.G., Toure, A., Mariko, M., Kiepe, P., 2009. Weed competitiveness of the lowland rice varieties of NERICA in the southern Guinea Savanna. Field Crop. Res. 114, 411-418.
- Saha, S.; Munda, S.; Singh, S.; Kumar, V.; Jangde, H.K.; Mahapatra, A.; Chauhan, B.S. 2021. Crop Establishment and Weed Control Options for Sustaining Dry Direct Seeded Rice Production in Eastern India. Agronomy , 11, 389.
- Sylla M., Traore K., Soro D., & Yode T. E. G., 2017. Evaluation des pratiques de gestion des adventices en riziculture irriguée dans la localité de Daloa,

centre-ouest de la Côte d'Ivoire. Agronomie Africaine 29 (1): 49 – 64.

- Touré A., Sogbedji J. M., and Gumedzoé Y. M. D., 2013. The critical period of weed interference in upland rice in northern Guinea savanna: Field measurement and model prediction. African Journal of Agricultural Research. Vol. 8(17), 1748-1759.
- Uprety R., 2005. System of Rice Intensification (SRI) Performance in Morang district during 2005 main season. Disponible: (http:// www. ciifad.cornell.edu/sri/ countries/ Nepal/neppardy05.pdf), (Consulté le 16 janvier 2015).