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Effect of integrated weed management on direct seeded upland rice under rainfed conditions of Assam

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ABSTRACT

Transplanting of rice in different seasons is by far the most popular method of rice culture. But presently, there has been a shift from transplanting to direct-seeding of rice in many parts of the country due to shortage of irrigation facility and labour. Keeping in view the importance, a study was conducted in order to evaluate the effect of 6 weed management practices in combination with 3 different direct seeded upland rice varieties and the data revealed that the percentage of grasses was higher followed by broad leaf in variety Maizubiron followed by Guni during the critical crop growth period. Lowest weed density at 20, 40 and 60 DAS was recorded in rice variety Inglongkiri under integrated weed management of Pretilachlor @ 1.5 kg ha^{-1} +Mechanical weeding. Higher grain yield and harvest index among rice varieties was recorded in Inglongkiri (1.98 t ha^{-1}) and application of pretilachlor either @ 0.75 or 1.5 kg ha^{-1} +Mechanical weeding 30 DAS resulted the higher grain yield (1.95t ha^{-1}) and harvest index over two years.

***Keywords*: Direct seeded rice, oxadiargyl, pretilachlor and weed management**

Direct seeding is being promoted due to impending climate change scenario in the world. The direct seeded rice has multiple benefits, but weed management is a major challenge towards the success of this crop as because weeds are comparatively dense than in transplanted rice situation resulted due to simultaneous emergence of rice and weeds and the absence of standing water during growing stages of the crop. Transplanting of rice in different seasons is the most popular method of rice culture, however due to overwhelmingly rainfed condition and labour scarcity, direct seeding has emerged as a bettersystem. Besides reducing duration, direct seeded rice improves the soil physical and chemical properties, which facilitates the growth of non-rice crops grown in rotation with rice (Singh, 2015). Yield loss in direct seeded rice varies depending on weed intensityas well as environmental factors. So proper weed management is a prerequisite in achieving optimum yield in direct seeded rice.

Keeping in view the situation as described above and the damage caused by weed in *ahu* (summer) rice, the present investigation was undertaken to ascertain the weed flora affecting growth and yield of *ahu*/summer rice and their dynamics.

MATERIALS AND METHODS

The field experiment was carried out during two consecutive *kharif* seasons of 2014 and 2015 in the Instructional-cum Research Farm of Assam Agricultural University, Jorhat, Assam, India which is situated at 26°47' N latitude and 94°12' E longitude and an elevation of 86.6 m above the mean sea level. The meteorological data revealed that during the crop growth period (April to August), considerable fluctuation was observed in weather parameters during both the years (2014 and 2015) as shown in the table 1. The experiment was set up in randomized complete block design with three (3) replications and 18 treatments with a plot area of 12 m^2 and undertaken in a well-drained medium land. Initially representative soil sample was collected from the depth of 0-15 cm at random for studying the physico- chemical properties (Table 2). The surface soil of the experimental site was sandy loam in texture, acidic in reaction (5.6), medium in organic carbon (0.57 %), medium in available nitrogen (297.87 kg ha^{-1}), low in available phosphorus (23.28 kg ha^{-1}) and low in available potassium (101.71 kg ha^{-1}).

The treatments comprised of three different autumn direct seeded rice varieties *viz. Guni, Inglongkiri and Maizubiron* and six different integrated weed management practices *i.e*Pretilachlor @ 0.75 kg ha^{-1}+ mechanical weeding at 30 DAS, Pretilachlor @ 1.5 kg ha^{-1}+mechanical weeding at 30 DAS, Oxadiargyl @ 0.1 kg ha^{-1}+ Mechanical weeding at 30 DAS, Oxadiargyl @ 0.2 kg ha^{-1}+ mechanical weeding at 30 DAS, mechanical weeding at 15 and 45 DAS andWeedy check. Seeds were sown in rows at spacing of 20 cm. The fertilizers were applied at a recommended dose 40:20:20 of N: P_2O_5:K_2O kg ha^{-1}with split application of nitrogenous fertilizer. Weed population study was done by collecting weeds at different intervals from an area of 1 m^2.Yield and other associated yield parameters was determined from 10 m^2 area in each plot.

RESULTS AND DISCUSSION

Weed distribution

Altogether, 18 species comprising sedges, broad leaved and grasses were found and they consisted of

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Table 1: Some climatological parameters of the experimental site [precipitation (mm), average monthly temperatures (°C) and relative humidity (%)] for 2014 and 2015

Year	Months	April	May	June	July	August
2014	Temperature (°c)	24.60	26.50	28.20	28.90	28.80
	Relative humidity (%)	68.50	84.00	83.00	85.00	86.50
	Rainfall (mm)	31.00	236.00	373.00	335.00	332.00
2015	Temperature (°c)	23.20	26.30	28.00	29.65	28.45
	Relative humidity (%)	83.00	84.00	87.00	81.00	86.50
	Rainfall (mm)	293.00	298.00	335.00	344.00	307.00
Long Term Avg (15 yrs)	Temperature (°c)	22.43	22.84	23.51	21.89	23.38
	Relative humidity (%)	76.30	84.50	87.00	81.00	86.50
	Rainfall (mm)	196.00	356.00	332.00	412.00	386.00

(Source: Department of Agricultural Meteorology, Assam Agricultural University, Jorhat, Assam)

Table 2: Physico-chemical characteristics of the experimental site

Soil properties	Content or value (%)	Textural class or rating
A. Physical analysis		
Sand (%)	65.08	
Silt (%)	18.66	Sandy loam in texture
Clay (%)	16.26	
B. Chemical analysis		
pH	5.6	Acidic
Organic carbon (%)	0.57	Medium
Available N (kg ha^{-1})	297.87	Medium
Available P_2O_5 (kg ha^{-1})	23.28	Low
Available K_2O (kg ha^{-1})	101.71	Low

Cynodon dactylon, Digitaria setigera, Panicum repens, Eleusine indica, Phyllanthus erineria, Chenopodium album, Ageratum conyzoides, *Leersia hexandra, Gnaphalium polycaulom, Commelina diffusa, Scroparia dulcis, Mimosa pudica, Borreria articularis*, *Mimosa pudica, Cyperus pilosus, Cyperusiria*, *Cyperus rotundus* and *Fimbristylis littoralis* (Table 3). It was observed that the weed population at 20 DAS in *Guni* comprised of 70.49% grass, 18.54% broad leaf and 10.97% sedge. In *Maizubiron,* weed population comprised of 67.78, 20.54 and 11.68% grass, broad leaf and sedge, respectively (Fig. 1). Whereas, in *Inglongkiri*, it comprised of 67.63% grass, 20.61% broad leaf and 11.76% of sedge. At 40 DAS, the weed composition was 56.80, 53.37 and 52.67% grass, 30.06, 32.06 and 31.64% broad leaf and 13.14, 14.47 and 15.69% sedge in *Guni*, *Inglongkiri* and *Maizubiron*, respectively. This composition at 60 DAS was 54.26, 53.42 and 55% grass, 18.06, 28.52 and 28.89% broad leaf and 17.91, 18.06, 16.11% in *Guni*, *Inglongkiri* and *Maizubiron*, respectively (Fig. 2, 3 and 4).

Among all the weed species, the most dominant species were *Cyperus rotundus* and *Cyperus iria* among sedge, *Cynodon dactylon* among the grass and *Ageratum conyzoides* among the broad leaved. Dominance of these weed species in upland direct seeded rice were also reported by Acharya *et al.* (2007). It might be due to favourable climatic conditions like high rainfall and high temperature in the different crop growth stages and also presence of vegetative propagules of *Cynodon dactylon* and *Cyperus rotundus* and rich soil seed bank of the other dominant weeds in soil that could help in early establishment and abundance of these weed species.

Weed density and dry weight

A significantly lower weed density and dry weight at early crop growth stage was recorded due to application of pretilachlor @ 0.75 kg ha^{-1} (Table 4) + mechanical weedingat 30 DAS and pretilachlor @ 1.5 kg ha^{-1}+mechanical weeding at 30 DAS while at later stages of crop growth, oxadiargyl @ 0.1 kg ha^{-1} +mechanical weeding at 30 DAS and oxadiargyl @ 0.2 kg ha^{-1}+ mechanical weeding at 30 DAS were able to suppress weeds better (Table 4).

The weed density was found to be lowest in the experimental plot treated with pretilachlor. This could

Table 3: Weed flora associated with upland direct seeded rice

Sl no.	*Category*	*Scientific name*	*Family*	*Common name*	
1.	**Grass**	*Cynodon dactylon* (L.) Pers.	Poaceae	Bermuda grass	
2.			*Digitaria setigera* Roth ex. Roem. &Schult	Poaceae	Crab grass
3.			*Panicum repens* L.	Poaceae	Torpedo grass
4.			*Eleusine indica* (L.) Gaertn.	Poaceae	Goose grass
5.			*Leersia hexandra* Sw.	Poaceae	Southern cutgrass
6.	**Broadleaved weeds**	*Phyllanthus urinaria* L.	Euphorbiaceae	Chamber bitter	
7.			*Chenopodium album* L.	Amaranthaceae	Common lamb's quarter
8.			*Ageratum conyzoides* L.	Asteraceae	Billygoat-weed
9.			*Gnaphalium polycaulon* Pers.	Asteraceae	Cutweed
10.			*Commelina diffusa* Burm.f.	Commelinaceae	Climbing day flower
11.			*Scroparia dulcis* L.	Plantaginaceae	Licorice weed
12.			*Mimosa pudica*	Fabaceae	Touch me not
13.			*Borreria articularis* (L. f.)F.N. Will	Rubiaceae	Shaggy button weed
14.			*Cuphea balsamona* Cham.&Schltdl.	Lythraceae	Cigar plant
15.	**Sedge**	*Cyperus pilosus*Vahl	Cyperaceae	Fuzzy flatsedge	
16.			*Cyperus iria* L.	Cyperaceae	Rice field flat sedge
17.			*Cyperus rotundus* L.	Cyperaceae	Purple Nutsedge
18.			*Fimbristylis littoralis* Gaudich.	Cyperaceae	Fringe-rush

Table 4: Effect of variety and integrated weed management on weed density at different days after sowing

Treatment	Weed density (no m^{-2})*(2014)			Weed density (no. m^{-2})*(2015)		
Variety	**20 DAS**	**40 DAS**	**60 DAS**	**20 DAS**	**40 DAS**	**60 DAS**
V_1: *Guni*	5.94 (36.33)	6.32 (41.06)	6.90 (47.40)	1.05 (0.89)	1.16 (0.94)	1.53 (2.12)
V_2:*Inglongkiri*	5.80 (34.89)	5.50 (32.05)	6.41 (41.31)	0.98 (0.52)	1.08 (0.72)	1.56 (2.23)
V_3: *Maizubiron*	6.71 (46.00)	5.81 (37.39)	6.88 (48.45)	1.14 (0.64)	1.20 (1.12)	1.55 (2.24)
SEm (±)	**0.20**	**0.25**	**0.30**	**0.05**	**0.07**	**0.06**
LSD (0.05)	**0.56**	**0.70**	**0.86**	**0.14**	**0.21**	**0.18**
Integrated weed management						
W_1:Pretilachlor @ 0.75 kg ha^{-1} + Mechanical weeding at 30 DAS	5.11 (25.78)	4.73 (22.13)	6.84 (46.51)	5.06 (24.33)	6.43 (41.57)	6.94 (47.89)
W_2:Pretilachlor @ 1.5 kg ha^{-1}+ Mechanical weeding at 30 DAS	5.04 (25.00)	5.12 (26.22)	6.56 (42.73)	4.73 (23.44)	6.55 (43.04)	6.84 (46.67)
W_3:Oxadiargyl @ 0.1 kg ha^{-1}+ Mechanical weeding at 30 DAS	5.53 (30.67)	4.70 (22.08)	6.19 (38.67	4.91 (25.00)	6.94 (48.62)	6.50 (42.67)
W_4:Oxadiargyl @ 0.2 kg ha^{-1}+ Mechanical weeding at 30 DAS	5.72 (32.89)	4.59 (21.00)	6.21 (38.33)	4.88 (25.33)	6.95 (48.72)	6.53 (42.56)
W_5:Mechanical weeding at 15 and 45 DAS	5.42 (54.89)	7.87 (61.44)	6.43 (41.00)	3.67 (12.44)	8.34 (70.31)	6.62 (43.67)
W_6:Weedy check	8.10 (65.22)	8.24 (68.11)	8.14 (67.07)	8.25 (46.67)	8.60 (73.66)	7.69 (59.78)
SEm (±)	**0.33**	**0.32**	**0.42**	**0.48**	**0.46**	**0.64**
LSD (0.05)	**0.94**	**0.92**	**1.21**	**1.38**	**1.32**	**NS**
Interaction (V x IWM)						
SEm (±)	**0.09**	**0.11**	**0.13**	**0.18**	**0.20**	**0.16**
LSD (0.05)	**0.25**	**0.32**	**0.38**	**0.52**	**0.58**	**0.46**

DAS: Days after sowing, NS: Non-significant

Note: * Square root transformed data. Figures in the parentheses are original data

Table 4.1: Interaction effect of variety and integrated weed management on weed density at 20 DAS (2014)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	4.78 (22.35)	4.98 (24.30)	5.57 (30.52)
W_2	5.30 (27.59)	4.81 (22.64)	5.01 (24.60)
W_3	4.98 (24.30)	5.01 (24.60)	6.59 (42.93)
W_4	5.36 (28.23)	4.98 (24.30)	6.81 (45.88)
W_5	7.53 (56.20)	6.87 (46.70)	7.86 (61.28)
W_6	7.70 (58.79)	8.17 (66.25)	8.41 (70.23)
SEm (±)	**0.09**		
LSD (0.05)	**0.25**		

Table 4.2: Interaction effect of variety and integrated weed management on weed density at 40 DAS (2014)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	5.33 (27.91)	4.23 (17.39)	4.62 (20.84)
W_2	6.03 (35.86)	4.92 (23.71)	4.41 (18.95)
W_3	5.47 (29.40)	4.02 (15.66)	4.51 (10.84)
W_4	5.07 (25.20)	4.64 (21.03)	4.16 (16.81)
W_5	7.86 (61.28)	7.76 (59.72)	7.99 (63.34)
W_6	8.15 (65.92)	7.33 (53.23)	9.25 (85.06)
SEm (±)	**0.11**		
LSD (0.05)	**0.32**		

Table 4.3: Interaction effect of variety and integrated weed management on weed density at 60 DAS (2014)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	6.54 (42.27)	7.10 (49.91)	6.89 (46.97)
W_2	6.55 (42.40)	6.77 (45.33)	6.35 (39.82)
W_3	6.87 (46.70)	5.04 (24.90)	6.67 (43.99)
W_4	6.77 (45.33)	6.04 (35.98)	5.81 (33.26)
W_5	6.84 (46.29)	6.28 (38.94)	6.16 (37.45)
W_6	7.80 (60.34)	7.21 (51.48)	9.42 (88.24)
SEm (±)	**0.13**		
LSD (0.05)	**0.38**		

*Note: * Square root transformed data. Figures in the parentheses are original data.*

Table 4.4: Interaction effect of variety and integrated weed management on weed density at 20 DAS (2015)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	4.92 (23.71)	5.05 (25.00)	5.21 (26.64)
W_2	4.00 (15.50)	3.48 (11.61)	3.53 (11.96)
W_3	4.39 (18.77)	5.21 (26.64)	5.15 (26.02)
W_4	4.24 (17.78)	4.25 (17.56)	6.15 (37.32)
W_5	4.43 (19.12)	4.71 (21.68)	5.05 (25.00)
W_6	9.43 (88.42)	6.98 (48.22)	8.35 (69.22)
SEm (±)	**0.18**		
LSD (0.05)	**0.52**		

Table 4.5: Interaction effect of variety and integrated weed management on weed density at 40 DAS (2015)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	5.73 (32.33)	7.20 (51.34)	6.36 (39.95)
W_2	5.92 (34.55)	7.17 (50.91)	6.56 (42.53)
W_3	6.36 (39.55)	7.84 (60.97)	6.64 (43.59)
W_4	7.50 (55.75)	6.80 (45.74)	6.54 (42.27)
W_5	8.12 (65.43)	7.74 (59.41)	8.72 (75.54)
W_6	8.63 (73.98)	8.46 (71.07)	9.15 (83.22)
SEm (±)	**0.20**		
LSD (0.05)	**0.58**		

Table 4.6: Interaction effect of variety and integrated weed management on weed density at 60 DAS (2015)

Integrated weed management	Variety		
	V_1	V_2	V_3
W_1	7.40 (54.26)	6.93 (47.52)	6.49 (41.62)
W_2	6.81 (45.88)	7.31 (52.94)	6.40 (40.46)
W_3	7.50 (55.75)	5.53 (30.08)	6.48 (41.49)
W_4	7.16 (50.77)	6.49 (41.62)	5.93 (34.66)
W_5	6.67 (43.99)	6.60 (43.06)	6.58 (42.80)
W_6	7.66 (58.18)	7.28 (52.50)	8.14 (65.76)
SEm (±)	**0.16**		
LSD (0.05)	**0.46**		

*Note: * Square root transformed data. Figures in the parentheses are original data.*

be due to better weed controlling ability of pretilachlor during the early stages over oxadiargyl, the later however, exhibited its prolonged effect. Duary *et al.* (2009) also recorded the lowest weed density in dry seeded rice by pre-emergence application of pretilachlor and hand weeding later. The rice varietal characteristics in combination to pre-emergence application of herbicides are responsible for lower weed density (Mann *et al.,* 2007). Ramesh *et al.* (2009) also observed that weed control efficiency registered with pre-emergence application of pretilachlor could result in superior growth, better yield attributes, yield and better weed control efficiency in direct seeded rice. The persistence of oxadiargyl might have caused better weed control efficiency up to the later stages of rice in the first year however; this effect might have been reduced due to higher rainfall in the second year.

The interaction effect of variety and integrated weed management was found significant (Table 4.1, 4.2 and 4.3). The lowest weed density and dry weight at 20 days after sowing (DAS) was noticed in *Inglongkiri* followed by *Guni* with application of pretilachlor @ 0.75 kg $ha^1$with subsequent garden hoeing and pretilachlor @ 1.5 kg ha^{-1} followed by garden hoeing (Table 4.4, 4.5 and 4.6). However, at 40 and 60 DAS, *Inglongkiri* combined with application of oxadiargyl @ 0.1 kg ha^{-1} followed by garden hoeing and oxadiargyl @ 0.2 kg ha^1 followed by garden hoeing was better in lowering the weed density and weed dry weight (Table 5). This might be due to the reason that *Guni* was a short duration variety with faster growth. Similarly, *Inglongkiri* has ability to suppress weed growth due to its canopy arrangement and plant height (Table 5.1, 5.2 and 5.3). Combined with varietal characteristics, application of pre-emergence herbicide pretilachlor and oxadiargyl could check weed growth which resulted in low weed density and dry weight.

The highest weed dry density and weed dry weight, at all the growth stages was recorded in weedy check. Various workers also found that during early part of the growing season, weeds accomplished 20-30% of their growth while rice had only 2-3% which evinced that the weed infestation can hamper normal crop growth and economic returns (Mutumba and Oganda, 2015).

Grain yield

Among the rice varieties tested, *Inglongkiri* recorded the highest grain yield of 2.02 t ha^{-1} in 2014 and 1.92 tha^{-1} in 2015 (Table 6) which was found to be significantly higher over *Guni* and *Maizubiron*., pretilachlor @ 0.75

Table 5: Effect of variety and integrated weed management on weed dry weight at different days after sowing

Treatment	Weed dry weight (g m^{-2})*(2014)			Weed dry weight (g m^{-2})*(2015)		
Variety	**20 DAS**	**40 DAS**	**60 DAS**	**20 DAS**	**40 DAS**	**60 DAS**
V_1: *Guni*	1.05 (0.89)	1.16 (0.94)	1.53 (2.12	1.23 (13.08)	1.26 (4.86)	1.71 (2.49)
V_2: *Inglongkiri*	0.98 (0.52)	1.08 (0.72)	1.56 (2.23)	1.16 (13.05)	1.23 (3.28)	1.77 (2.51)
V_3: *Maizubiron*	1.14 (0.64)	1.20 (1.12)	1.55 (2.24)	1.35 (16.32)	1.36 (5.22)	1.92 (2.48)
SEm (±)	**0.05**	**0.07**	**0.06**	**0.06**	**0.07**	**0.15**
LSD (0.05)	**0.14**	**0.21**	**0.18**	**0.17**	**0.20**	**0.44**
Integrated weed management						
W_1:Pretilachlor @ 0.75 kg ha^{-1} + Mechanical weeding at 30 DAS	0.94 (0.39)	0.97 (0.45)	1.43 (1.54)	1.18 (13.14)	1.14 (1.85)	1.55 (2.36)
W_2:Pretilachlor @ 1.5 kg ha^{-1}+ Mechanical weeding at 30 DAS	0.93 (0.37)	0.98 (0.48)	1.40 (1.47)	1.11 (12.66)	1.09 (2.28)	1.39 (2.35)
W_3:Oxadiargyl @ 0.1 kg ha^{-1}+ Mechanical weeding at 30 DAS	0.99 (0.50)	0.96 (0.42)	1.22 (1.02)	1.17 (13.50)	1.08 (2.92)	1.48 (2.18)
W_4:Oxadiargyl @ 0.2 kg ha^{-1}+ Mechanical weeding at 30 DAS	0.90 (0.30)	0.94 (0.39)	1.21 (0.97)	1.08 (13.68)	1.03 (3.94)	1.23 (2.16)
W_5:Mechanical weeding at 15 and 45 DAS	0.97 (0.45)	1.23 (1.02)	1.29 (1.19)	1.15 (6.72)	1.32 (6.19)	1.32 (2.25)
W_6:Weedy check	1.61 (2.09)	1.79 (2.79)	2.71 (7.01)	1.79 (25.20)	2.03 (9.54)	3.81 (3.67)
SEm (±)	**0.06**	**0.05**	**0.19**	**0.07**	**0.11**	**0.32**
LSD (0.05)	**0.17**	**0.14**	**0.54**	**0.21**	**0.33**	**0.91**
Interaction (V x IWM)						
SEm (±)	**0.02**	**0.03**	**0.03**	**0.03**	**0.03**	**0.05**
LSD (0.05)	**NS**	**0.10**	**0.08**	**NS**	**0.09**	**NS**

DAS: Days after sowing,: Square root transformed data. Figures in the parentheses are original data, NS: Non-significant*

Table 5.1: Interaction effect of variety and integrated weed management on weed dry weight at 40 DAS (2014)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	0.97 (0.44)	0.90 (0.31)	1.03 (0.56)
W_2	1.04 (0.58)	0.94 (0.38)	0.97 (0.44)
W_3	0.99 (0.48)	0.88 (0.27)	1.00 (0.50)
W_4	0.96 (0.42)	0.99 (0.48)	0.88 (0.27)
W_5	1.23 (1.01)	1.22 (0.99)	1.25 (1.06)
W_6	1.26 (1.09)	1.54 (1.87)	1.38 (1.40)
SEm (±)		**0.03**	
LSD (0.05)		**0.10**	

Table 5.2: Interaction effect of variety and integrated weed management on weed dry weight at 60 DAS (2014)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	1.48 (1.69)	1.42 (1.52)	1.40 (1.46)
W_2	1.46 (1.63)	1.35 (1.32)	1.40 (1.46)
W_3	1.24 (1.04)	1.29 (1.16)	1.14 (0.80)
W_4	1.29 (1.16)	1.25 (1.06)	1.08 (0.67)
W_5	1.28 (1.14)	1.29 (1.16)	1.31 (1.22)
W_6	2.56 (6.05)	2.73 (6.95)	2.85 (7.62)
SEm (±)		**0.03**	
LSD (0.05)		**0.08**	

Table 5.3: Interaction effect of variety and integrated weed management on weed dry weight at 40 DAS (2015)

Integrated weed management	Variety*		
	V_1	V_2	V_3
W_1	1.19 (0.92)	1.18 (0.89)	1.04 (0.58)
W_2	1.18 (0.89)	1.03 (0.56)	1.02 (0.54)
W_3	1.13 (0.78)	1.05 (0.60)	1.07 (0.64)
W_4	1.13 (0.78)	0.95 (0.40)	1.00 (0.50)
W_5	1.16 (0.85)	1.43 (1.54)	1.37 (1.38)
W_6	1.75 (2.56)	1.71 (2.42)	2.63 (6.42)
SEm (±)	**0.03**		
LSD (0.05)	**0.09**		

*: *Square root transformed data. Figures in the parentheses are original data.*

kg ha^{-1}followed by mechanical weeding at 30 DAS resulted the highest grain yield in both the years and the pooled data showed its significant superiority over the mechanical weed management of Mechanical weeding twice.

Straw yield

Data showing effects of varieties and integrated weed management on straw yield presented in the table 6 revealed that *Inglongkiri* produced significantly higher straw yield (47.07 and 53.84 kg ha^{-1}) in both the years than *Guni* and *Maizubiron*. Results also indicated significant variation among integrated weed management practices where the highest straw yield of 43.15 and 49.47 kg ha^{-1} during 2014 and 2015 respectively was recorded with the application of pretilachlor @ 0.75 kg ha^{-1}followed by mechanical weeding at 30 DAS. However, it was found to be at par with remaining treatments other than only Mechanical weeding at 15 and 45 DAS and weedy check in both the years to which it was superior.

Table 6: Effect of variety and Integrated weed management on grain yield, straw yield and harvest index of the crop

Treatment	Grain yield (2014)	Grain yield (2015)	Straw yield (2014)	Straw yield (2015)	Harvest index (2014)	Harvest index (2015)
Variety	**tha^{-1}**	**tha^{-1}**	**$kgha^{-1}$**	**$kgha^{-1}$**	**%**	**%**
V_1: *Guni*	1.34	1.38	31.25	33.61	42.48	34.77
V_2: *Inglongkiri*	2.03	1.92	47.07	53.84	43.09	35.29
V_3: *Maizubiron*	1.29	1.25	26.86	32.94	42.71	34.82
SEm (±)	**1.07**	**0.80**	**2.04**	**2.19**	**-**	**-**
LSD (0.05)	**3.07**	**2.31**	**5.84**	**6.83**	**-**	**-**
Integrated weed management						
W_1:Pretilachlor @ 0.75 kg ha^{-1} + Mechanical weeding at 30 DAS	1.91	1.98	43.15	49.47	43.14	35.51
W_2:Pretilachlor @ 1.5 kg ha^{-1} + Mechanical weeding at 30 DAS	1.89	1.90	41.88	47.43	43.23	35.54
W_3:Oxadiargyl @ 0.1 kg ha^{-1}+ Mechanical weeding at 30 DAS	1.76	1.83	41.58	46.87	43.00	35.46
W_4:Oxadiargyl @ 0.2 kg ha^{-1} + Mechanical weeding at 30 DAS	1.72	1.67	41.12	47.13	42.96	35.48
W_5:Mechanical weeding at 15 and 45 DAS	1.39	1.32	31.38	38.56	42.73	35.46
W_6:Weedy check	0.67	0.40	11.25	11.34	41.49	32.32
SEm (±)	**1.12**	**0.89**	**2.83**	**2.62**	**-**	**-**
LSD (0.05)	**3.22**	**2.53**	**8.14**	**7.53**	**-**	**-**
Interaction (V x IWM)						
SEm (±)	**0.48**	**0.36**	**0.91**	**0.98**	**-**	**-**
LSD (0.05)	**1.37**	**1.03**	**2.61**	**2.81**	**-**	**-**

DAS: Days after sowing, NS: Non-significant

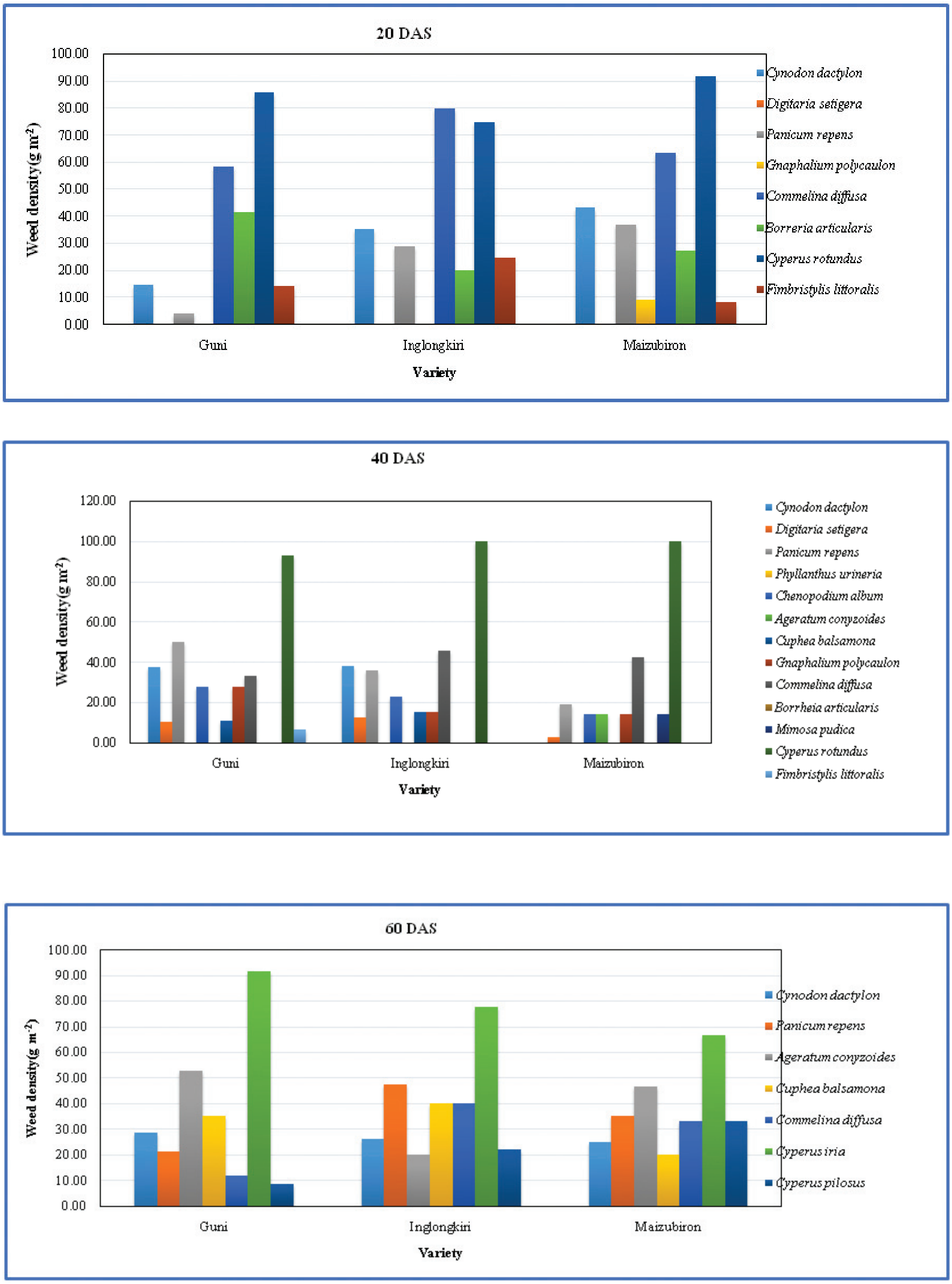

Fig. 1: Species wise distribution of weeds at 20, 40 and 60 DAS in weedy plot

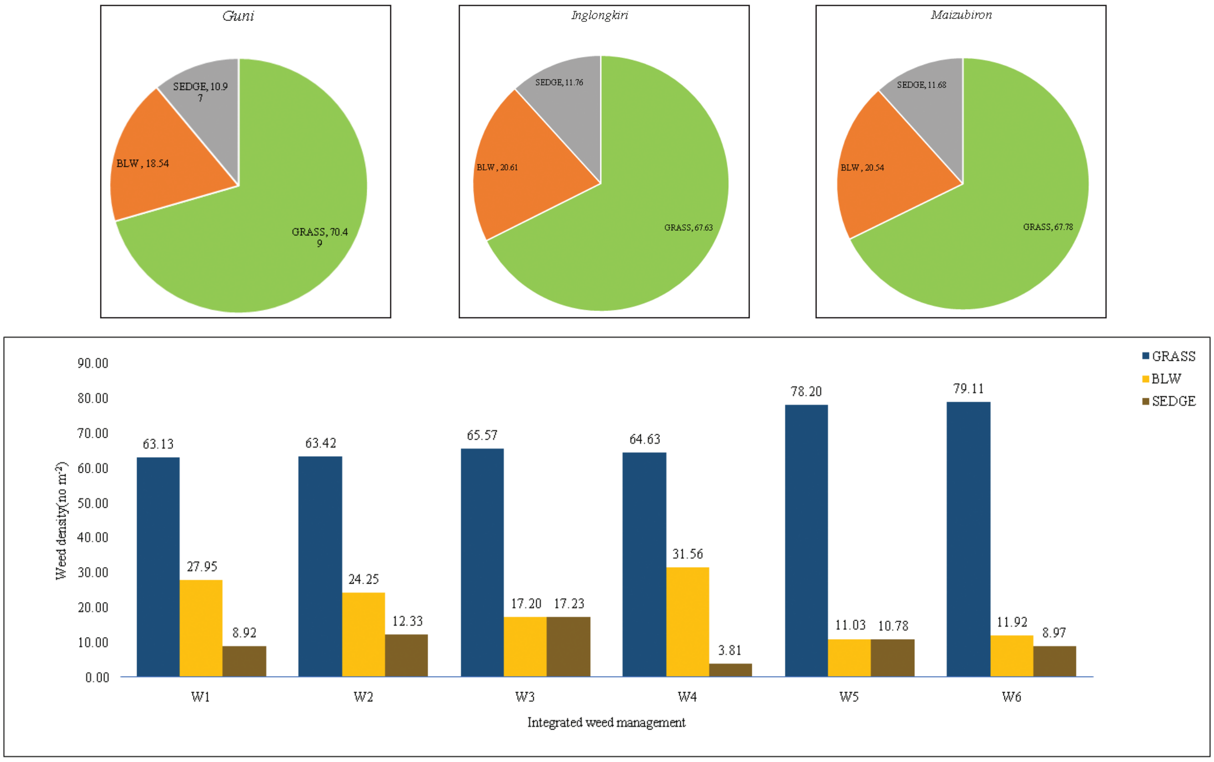

Fig. 2: Status of weed flora affected by variety and integrated weed managementat 20 DAS

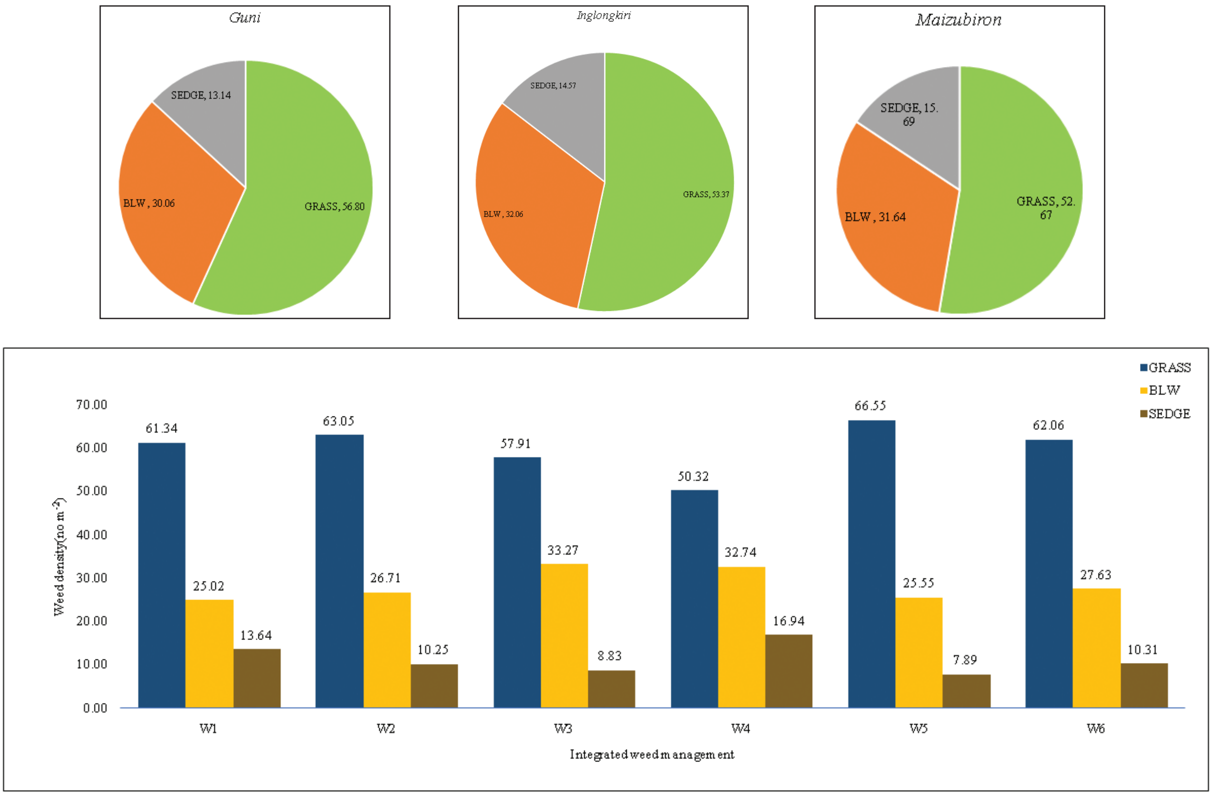

Fig. 3: Status of weed flora affected by variety and integrated weed managementat 40 DAS

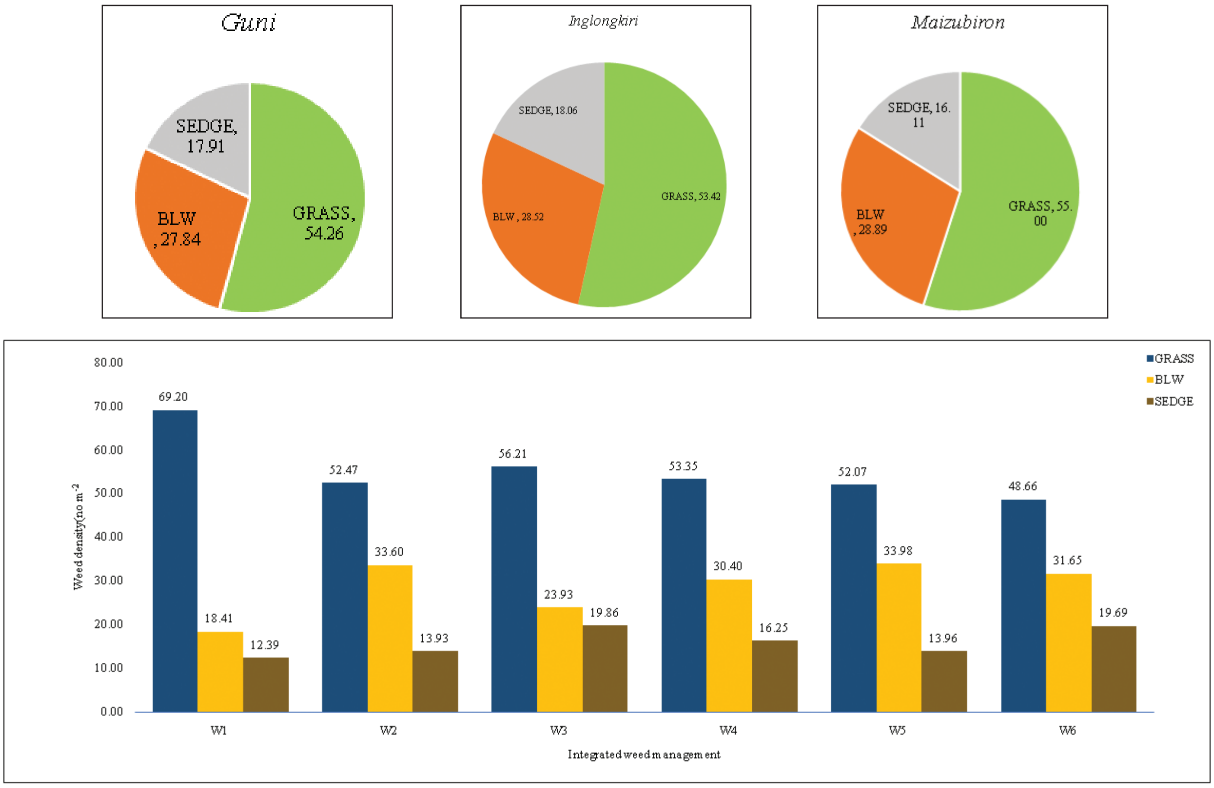

Fig. 4: Status of weed flora affected by variety and integrated weed managementat 60 DAS

Harvest index

The harvest index of rice varieties differed in both the years and the variety *Inglongkiri* registered the highest value of 43.09 and 35.29% in 2014 and 2015, respectively. It was followed by *Guni* and *Maizubiron* in descending order (Table 6). It is evident from results that the trends in grain and straw yield mainly affected the harvest index. However, the values in the second year were lower than the respective values of the first year mainly due to higher rainfall in the second year resulting higher dry matter accumulation but limited partitioning ability of the varieties.

In direct seeded upland *ahu* rice of Assam, the most dominant weed species were *Cyperus rotundus* and *Cyperus iria* among the sedges, *Cynodon dactylon* among the grasses and *Ageratum conyzoides* among the broad leaved. On the basis of all the parameters studied in respect of weed, crop, soil biochemical and microbial properties, the combination of upland rice variety *Inglongkiri* along with application of pretilachlor @ 0.75 kg ha^{-1} followed by mechanical weeding @ 30 DAS was conclusively found best for effective weed control, soil health, crop growth, yield and economic profit from this study. There is a need to assess the yield loss caused by each one of the weeds, find out appropriate management and plausible resistance by using biotechnology.

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