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Competitive study of weeds*Commelina diffusa* and *Alternanthera sessilis* with Rice (*Oryza sativa*) cultivation: An *in vitro* study

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Abstract

Weeds are major competitors of rice growing in the farming land. Supply of nutrients for the productivity of rice enhances weed growth. Identification of major weeds from agricultural land and their quantitative estimation as competitors must be required for proper management of weeds. Present study was conducted in tubs and plastic trays to identify the growth status of weeds compared with the growth record of rice (*in vitro* study) and estimate the biochemical activities during competition.*Commelina diffusa* and*Alternanthera sessilis* are the common perennial weeds found in all rice fields of West Bengal, India. Different morphological parameters of rice plants and weeds were estimated after seven days of intervals for three months. Biochemical study was also conducted after four week of plantation of rice plants and weeds. Growth of rice was inhibited due to profuge growth of *Commelina diffusa* and*Alternanthera sessilis*. Yield of grains and plant biomass were also decreased. This study revealed that *Alternanthera sessilis* was more competitor of rice than *Commelina diffusa*. Without proper management of weeds, maximum rice productivity would not have been possible.

Keywords:

Rice;
Weed;
Commelina diffusa;
Alternantherasessilis;
Competition.

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1. Introduction

Agriculture sector plays a vital role in the Indian economy to provide food security for the increasing population of India. Productivity of Rice (*Oryza sativa*) is a major issue because it is the primary food grain in India. West Bengal is the largest producer state of rice during 2015-16. West Bengal produces 15.75 Million Tonnes of rice prior to Uttar Pradesh (12.51 Million Tonnes) and Punjab (11.82 Million Tonnes), where as 104.32 Million Tonnes of rice are produced in India during 2015-2016 [1]. Rice is cultivated during two main seasons (*Kharif* and *Rabi*) in India. Being a semi-aquatic crop, it requires high supply of water for its growth. For meeting water supply, maximum cultivers select *kharif* season (rainy season) for rice cultivation. Cultivers produce 86.49 % of rice during *kharif* season where as 90.13 % of firm land is cultivated during this season in India for last few years (2010-2015) [1]. Association of weeds and crop is not relatively new. When crop was cultivated commercially, a variety of volunteer undesirable weeds was grown simultaneously with crop to utilize nutrients and all other factors requiring for growth of crop [2]. Growth of rice was reduced when rice was challenged with salt tolerant weed species (*Ehinochloa colona*, *Cyperus iria* and *Jussia linifolia*). Morphological parameters like plant height, number of tillers, grain weight and biochemical parameters like chlorophyll content was reduced due to crop-weed competition [3]. A mathematical modelling showed that direct-seeded rice cultivation was inhibited by the competition of weed species. Number of penicles, grains per penicle and grain weight was affected for rice-weed competition [4]. Proper weed management is required to obtain maximum production of rice. Grain yield loss was observed when proper weed control was not performed between 20 to 50 DAS (days after seddling). This period played a pivotal role in rice-weed competition [5]. Critical period of competition was also observed by Shad et al. in 1988. “Basmati-370” varaity was adversely affected by *Fimbristylis littoralis* and *Echinochloa crusgalli*. Growth of rice variety was maximally reduced without appropriate weed management between 3 to 6 weeks [6]. *Commelina diffusa* and *Alternanthera sessilis* are common perennial herbs found in different agricultural fields of West Bengal, India [7]. These weeds are naturally grown in rice field during *kharif* season. *Commelina diffusa* is a creeping weed and grows profusely throughout the ground. Rooting systems have been observed at the nodes of this weed which enhances reproduction vegetatively [8]. It is used as a fodder crop for protein supplement of ruminants [9]. It also reduces soil erosion with ground coverage [10]. *Alternanthera sessilis* consists of short petioled leaves opposite in equal pair. This herb also contains white, sessile, small flowers in globose-cylindric spike. This weed has some medicinal value. Leaves of *Alternanthera sessilis* are active against skin diseases and eye diseases [11]. Leave extracts of this herb are also responsible for anti-inflammatory activity [12].The main objective of this study is to quantify competitive relationship between weeds and rice. Morphological and biochemical studies help to quantify competitive behaviour which is also necessary to manage weeds successfully.A survey was conducted from different rice field of North 24 Parganas districts of West Bengal, India during *kharif* season. Weeds were selected for this study by consultation with farmers. *Commelina diffusa* and *Alternanthera sessilis* were also grown profusely at all rice fields of survey area.

2. Research Method

2.1. Collection of Rice and Weeds for *in-vitro* study:

Commelina diffusa and *Alternanthera sessilis* were collected from the local agricultural field and transplanted into plastic trays and tubs as early as possible. *Aman* variety of rice (*Pratik*) was collected from local nursery and 20 days of seedlings were replanted into trays and tubs for *in vitro* study.

2.2. Soil preparation and fertilizer addition:

Soil was collected from local agricultural field and dried for one month to grind properly. After mixing whole soil accurately, it was transferred to trays and tubs for *in vitro* study. Suphala (15:15:15) was added to soil @ 550 gm/*katha* just before transplantation of rice and weeds. After 15 days of transplantation (15 DAT), urea was applied to soil @200 gm/ *katha*. Finally, urea and potash (@200 gm/*katha*) was added simultaneously after 45 DAT to get healthy plants.

2.3. Prior to competition study:

Six hill of rice plants were transplanted into trays where as two hill of rice plants were transplanted into tubs. All the hills which consist of six seedlings each were equally separated by 12 cm. *Commelina diffusa* and

Alternanthera sessilis were replanted simultaneously for competition study. Two seedlings of weed were competed with each hill of rice plant in all study.

2.4. Morphological study:
Morphological study was done weekly and it was continued upto three months. Different morphological parameters like height of rice plant, number of tillers per hill, root length, internodal distance, and number of panicle per hill, length of penicle per hill, weight of penicle per hill, weight of rice plant per hill and weight of grain were estimated in weed free and weedy conditions. Weeds growth including number of weeds per hill, percentage of coverage of weeds and weight of weeds per hill of rice were observed in competition experiment.

2.5. Biochemical study:
Biochemical parameters like chlorophyll content, protein content and catalase activity were estimated after 0 DAT, 28 DAT and 56 DAT. Rice plant extracts and weed extracts were prepared before biochemical assay.

2.6. Extraction procedure for Biochemical Assay:
All plant materials (Rice plant, *Commelina diffusa* and *Alternanthera sessilis*) were cleaned with tap water and distilled water respectively. It was transferred in a laboratory as early as possible after collection. Whole plant was chopped into small pieces individually and weighted in an electronic balance. 10 gm of whole plant parts were soaked with distilled water (1:10 w/v) and blended in a mortar and pestle for protein and catalase estimation. Plant root was removed for chlorophyll estimation. Aqueous plant extracts were filtered through cheese cloth and filtrate was collected in non reactive plastic containers and kept in a refrigerator at -20^0C for further study.

2.7. Estimation of Chlorophyll:
Chlorophyll was estimated according to Lichtenthaler *et. al*., (1983) from weed and rice samples [13]. Plant extracts were centrifuged at 5000 rpm for 15 min. Supernatant was collected and it was mixed with 95% ethanol (1:2 v/v) properly to obtain maximum chlorophyll molecule. Total Chlorophyll content (C_{total}) was estimated spectrophotometrically at the wavelength of 665nm and 649nm separately.
C_{total} (µg/ml) = $24.96A_{665} + 9.56A_{649}$
Where as A_{665} and A_{649} denote absorbance at 665nm and absorbance at 649nm respectively.

2.8. Estimation of Protein:
Protein content of weeds and rice plant were analysed by Lowry's method [14]. Plant extract was equally mixed with absolute alcohol and it was centrifuged at 5000 rpm for 15 min. Process was done subsequently until a clear extract was obtained. Supernatant was collected and it was reacted with alkaline copper sulphate reagent (1:3 v/v) for 15 min in dark. Then 0.5 ml of Folin Ciocalteau solution was added in it and it was further kept in dark for 30 min. Blue purple color complex was developed for tyrosine and trytophan residues of protein and it was estimated spectrophotometrically at 595nm.

2.9. Estimation of Catalase:
Catalase activity was estimated by using conventional titrimetric methods developed by von Euler and Josephson in 1926[15]. 100 ml of 0.0067 M cold H_2O_2 was prepared as a substrate of catalase enzyme in phosphate buffer (pH 6.8). Then 1ml of rice plant extract or weed extract was added to it and mixed properly. 5 ml of aliquot was quickly collected from it and mixed with 2 N H_2SO_4 to titrate with 0.005 N $KMnO_4$. Same volume of aliquot was also collected after various intervals and titrated with $KMnO_4$. A standard curve was prepared for calculating monomolecular k values at zero time by extrapolation. This value indicated catalase activity and it was expressed as unit of catalase per ml of plant extract (U/ml).

3. Results and Analysis

3.1. Morphological Study:
Morphological study shows the the growth status of rice compared with the growth record of weeds. Growth record of *Commelina diffusa* and *Alternanthera sessilis* were also estimated for understanding challenge between rice and weeds.

3.2. Study of rice plant height, tillers per hill, root length and internodal distance:
Morphological parameters like plant height, tillers per hill, root length and internodal distance were analysed in weed free condition and weedy conditions (Table 1). Rice plant height was significantly changed in weed-free condition than weedy condition. Plant height was higher and it was reached upto 101.5 cm in weed-free condition (control experiment) after three months where as it was reduced by 16% and 27% when rice was challenged with *Commelina diffusa* and *Alternanthera sessilis* respectively (Figure 1). Tiller number is directly related to crop production. Increasing tiller number enhances plant biomass and crop productivity. Number of tillers per hill was also reduced by weeds. Most challenge was observed when rice was competed with *Alternanthera sessilis*. At 90 DAT, weed-free rice plant produced highest number of tillers per hill (16.4), where as competition with *Commelina diffusa* and *Alternanthera sessilis* produced 11.1 and 9.8 number of tillers per hill respectively (Figure 2).Root length and internodal distance of plant are two important growth parameters. Both parameters were negetively affected due to competition. Root length of plant was increased gradually and reached upto 42 cm after 90 DAT in weed free condition. Root length was decreased into 37.6 cm and 36 cm after 90 DAT while rice plant was competed with *Commelina diffusa* and *Alternanthera sessilis* respectively (Figure 3). Internodal distance was mostly affected by *Alternanthera sessilis*, where as less effect was observed when competition was found between rice plant and *Commelina diffusa*(Figure 4).

3.3. Study of panicle and crop production:
Number of panicle, length of panicle and weight of panicle ensure crop productivity. Higher number of grains is obtained if number of panicle and length of panicle are found optimally. For getting maximum production of rice, all these three parameters (number of panicle, length of panicle and weight of panicle) must be found optimally.Morphological parameters like number of panicle, length of panicle and weight of panicle were estimated in weed free condition and weedy condition (Table 2).

Table 1:Result of rice plant height, tillers per hill, root length and internodal distance

Days After Transplantation (DAT)	**Height of Rice plant (cm)**			**Tillers per hill**			**Root length of Rice plant (cm)**			**Internodal distance of Rice plant (cm)**		
	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*
0 DAT	20.7	20.7	20.6	6	6	6	4.2	4.2	4.3	0	0	0
7 DAT	23.8	21.9	21.4	6	6	6	10.6	6.4	6.2	0	0	0
14 DAT	25.3	23.6	22	6	5.9	5.7	14.7	8.4	7.3	2.78	2.58	2.33
21 DAT	37.2	33.4	31.8	6.3	6	5.6	24.3	18.3	16.9	2.8	1.69	1.49
28 DAT	47	44	40.8	12.4	10.7	9.8	29.5	24.9	22.3	2.95	1.96	1.73
35 DAT	57.6	52.7	49.7	15.3	11.2	10	33.7	26.2	25.8	3.34	2.81	2.55
42 DAT	64.2	53.8	51.8	13.1	8.9	7.6	35.5	27.8	27.4	3.88	3.14	2.73
49 DAT	77.7	55.6	55.1	14.2	9.2	7.8	35.8	31.3	30.6	4.54	3.52	3.23
56 DAT	90	60.6	58.6	15.7	9.5	8	37.7	33.7	32.3	5.19	3.84	3.37
63 DAT	94.2	65.7	61	15.8	10.1	8.7	39.7	34.8	33.8	6.25	4.47	4.32
70 DAT	98.1	74.6	65.1	16.2	10.8	9.6	41.4	37.1	35.7	7.48	5.58	5.26
90 DAT	101.5	85.3	74.6	16.4	11.1	9.8	42	37.6	36	10.3	7.66	7.17

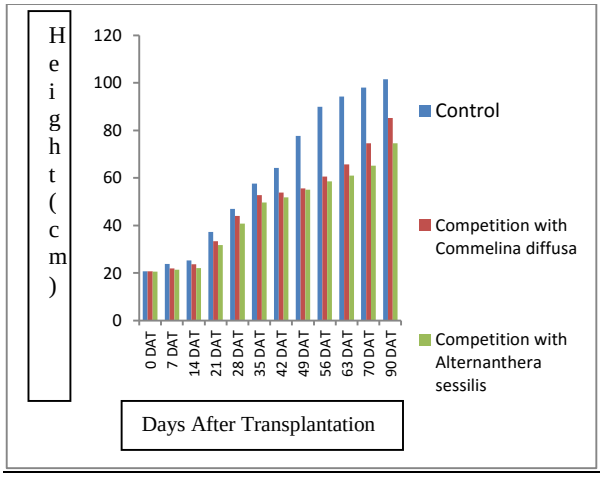

Figure 1.Height of Rice plant (cm) in Weed- free (Control) and Weedy Condition

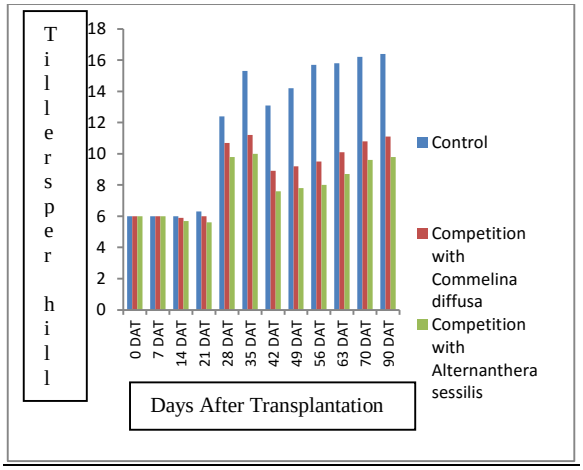

Figure 2. Tillers per hill in Weed-free (Control) and Weedy Condition

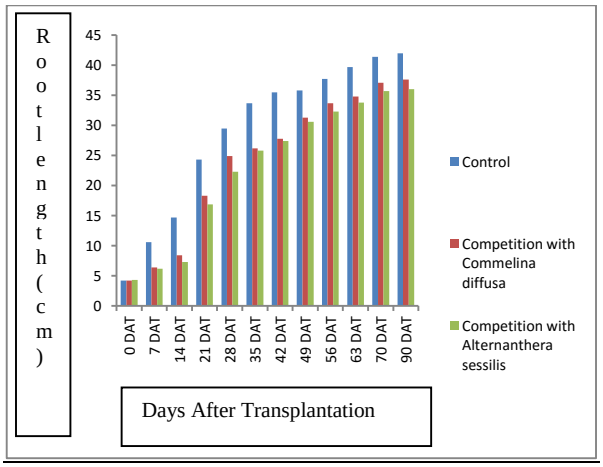

Figure 3. Root length of Rice plant (cm) in Weed-free (Control) and Weedy Condition

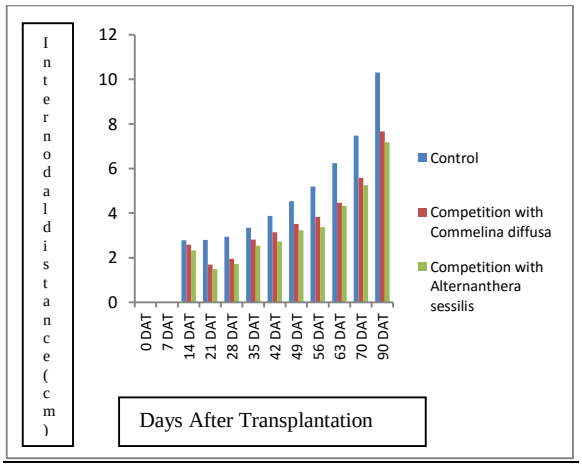

Figure 4. Internodal distance of Rice plant (cm) in Weed-free (Control)and Weedy Condition

This *in vitro* experiment showed that panicle came between 42 DAT and 49 DAT. Number of panicle per hill was varied from 9.6 to 16.3 after 90 DAT.

Highest number of panicle per hill was obtained in weed-free condition, where as least number of panicle was found in weedy condition (Competition with *Alternanthera sessilis*) (Figure 5). Length of panicle per hill was ranged from 18.21 cm to 24.30 cm.It was reduced by 14.40% and 25.06% when rice was competed with *Commelina diffusa* and *Alternanthera sessilis* respectively (Figure 6). Weight of panicle per hill was also reduced by weeds. A drastic change in weight was observed among three rice plants.Competition reduced 47.72% and 53.60% weight loss of panicle per hill (Figure 7). Weight of grains per hill is vital for food security, where as weight of rice plant per hill plays a pivotal role for fodder production. Weight of grain per hill was varied from 11.789 gm to 28.863 gm. Weed-free condition produced 28.863 gm of grain after 90 DAT, where as 52.93% and 59.16% reduction were found when rice was competed with *Commelina diffusa* and *Alternanthera sessilis* respectively (Figure 8). Weight of rice plant was also decreased due to competion with *Commelina diffusa* and *Alternanthera sessilis*. It was mostly reduced (44.71%) when rice was competed with *Alternanthera sessilis*(Figure9).

Table 2: Result of panicle and crop production

Days After Transplantation (DAT)	Number of Panicle per hill			Length of panicle per hill (cm)			Weight of Panicle per hill (gm)			Weight of grains per hill (gm)			Weight of rice plant per hill (gm)		
	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*	Control	Competition with *Commelina diffusa*	Competition with *Alternanthera sessilis*
0 DAT	0	0	0	0	0	0	0	0	0	0	0	0	4.59	4.6	4.6
7 DAT	0	0	0	0	0	0	0	0	0	0	0	0	6.38	5.35	5.192
14 DAT	0	0	0	0	0	0	0	0	0	0	0	0	9.43	7.156	6.786
21 DAT	0	0	0	0	0	0	0	0	0	0	0	0	18.041	9.275	9.195
28 DAT	0	0	0	0	0	0	0	0	0	0	0	0	25.23	13.25	12.105
35 DAT	0	0	0	0	0	0	0	0	0	0	0	0	29.16	17.07	14.918
42 DAT	0	0	0	0	0	0	0	0	0	0	0	0	37.654	19.96	17.197
49 DAT	1.8	0.9	0.8	15.75	6.67	4.52	1.435	0.474	0.325	1.132	0.305	0.145	43.361	22.75	19.773
56 DAT	8	5.4	5.2	17.91	14.22	11.93	5.767	3.29	2.848	4.415	1.882	1.653	48.564	25.68	22.14
63 DAT	15.5	9.7	9.2	19.75	16.9	15.26	12.057	7.202	6.073	9.184	5.187	4.822	51.404	30.55	26.612
70 DAT	16.2	10.4	9.5	22.45	17.99	16.62	13.85	8.303	6.761	9.908	5.616	5.363	56.417	37.3	29.271
90 DAT	16.3	10.5	9.6	24.3	20.8	18.21	31.304	16.363	14.526	28.863	13.301	11.789	71.325	45.69	39.439

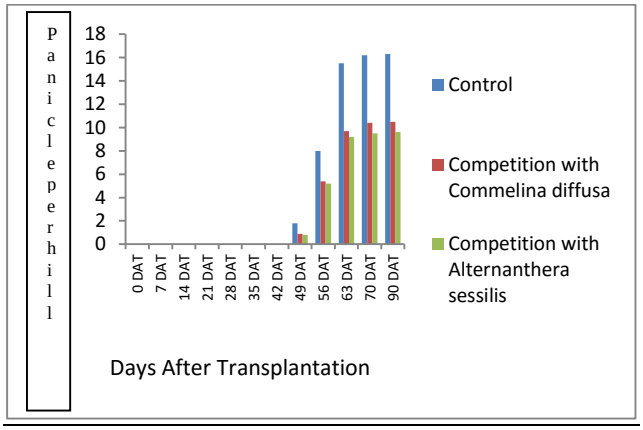

Figure 5. Number of Panicle per hill in Weed-free(Control) and Weedy Condition

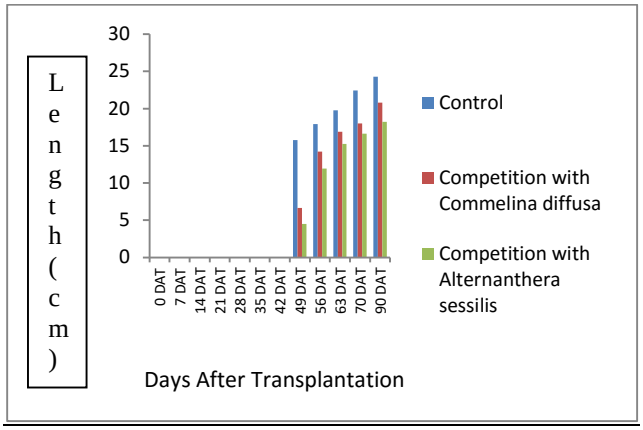

Figure 6.Length of Panicle (cm) per hill in Weed-free(Control) and Weedy Condition

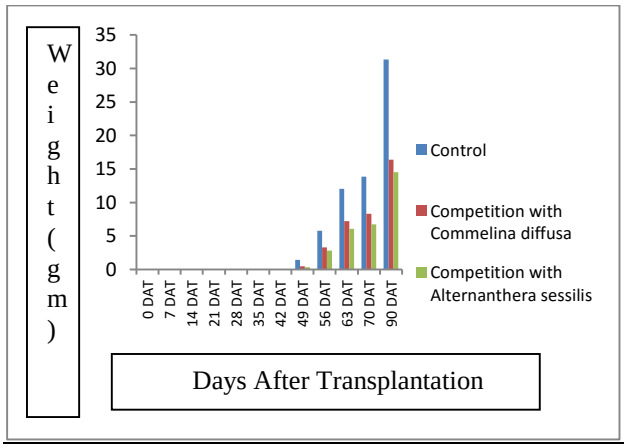

Figure 7.Weight of Panicle (gm) per hill in Weed-free(Control) and Weedy Condition

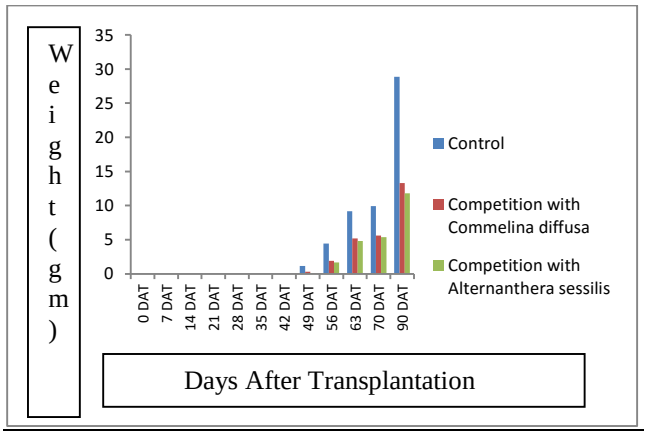

Figure 8.Weight of grains (gm) per hill in Weed-free(Control) and Weedy Condition

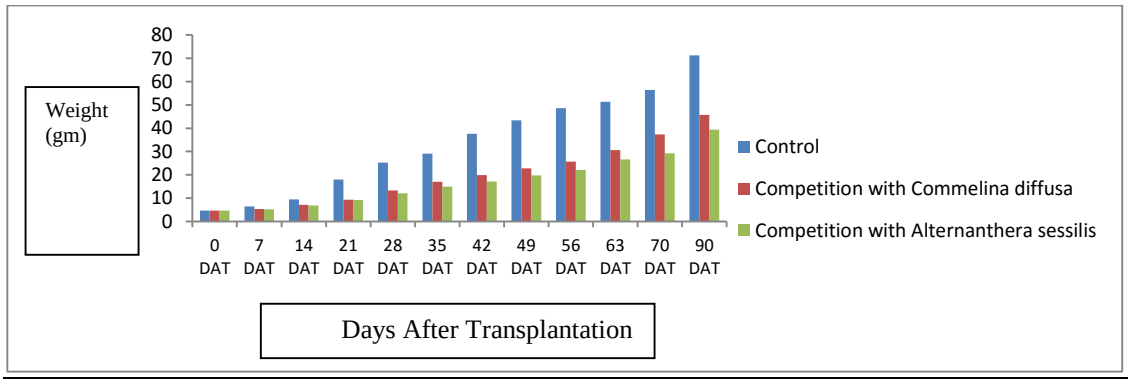

Figure 9: Weight of rice plant (gm) per hill in Weed-free(Control) and Weedy Condition

3.4.Study of weed growth:

Weeds growth including number of weeds per hill of rice, percentage of coverage of weeds and weight of weeds per hill of rice are important for proper weed management. This *in vitro* study revealed growth status of

Commelina diffusa and *Alternanthera sessilis* when these were grown with rice (Table 3). Number of weeds were increased gradually upto 49 DAT. Then it was decreased gradually upto 90 DAT. Number of *Alternanthera sessilis* was higher than *Commelina diffusa* between 14 DAT to 90 DAT (Figure 10). Being a creeping herb, *Commelina diffusa* covered the study area quickly. 80% coverage was observed between 28 DAT and 35 DAT and it was continued upto 63 DAT. *Alternanthera sessilis* covered the area upto 80% between 35 DAT and 42 DAT and it was also continued upto 63 DAT. Percentage of coverage was drastically reduced after 63 DAT (Figure 11). Weight of weeds per hill of rice plant was also increased upto 56 days. Weight of weeds was drastically reduced after 63 days (Figure 12).

Table 3: Study of weed growth

Days After Transplantation (DAT)	**Number of weeds per hill of rice**		**Percent coverage of weeds (%)**		**Weight of weeds per hill of rice plant (gm)**	
	Number of *Commelina diffusa*	Number of *Alternanthera sessilis*	Percent coverage of *Commelina diffusa* (%)	Percent coverage of *Alternanthera sessilis* (%)	Weight of *Commelina diffusa* (gm)	Weight of *Alternanthera sessilis* (gm)
0 DAT	2	2	5	5	4.33	4.42
7 DAT	2	2	5	5	7.23	8.15
14 DAT	3.3	4.7	10	10	9.72	11.21
21 DAT	5.9	6.3	25	15	20.53	21.61
28 DAT	6.2	10.7	40	30	35.53	32.68
35 DAT	8.3	13	80	50	45.57	43.9
42 DAT	8.6	18.7	80	80	54.78	55.66
49 DAT	10.1	24.6	90	100	66.55	63.77
56 DAT	9.9	22	90	100	72.69	50.87
63 DAT	8.8	18.6	80	80	35.78	34.91
70 DAT	3.2	11.2	10	30	5.71	17.74
90 DAT	1	1.5	2	3.85	1.89	3.98

Growth of rice plant and weeds (*Commelina diffusa* and *Alternanthera sessilis*) was ceased upto 14 DAT. At that time, both rice plant and weeds tried to adjust to *in vitro* conditions. Root length of rice plant was increased significantly because they tried to take up nutrients form soil of pot culture. Plant height was also increased upto 22% in weed-free condition, where as it was increased upto 14% and 6.80% when rice was competed with *Commelina diffusa* and *Alternanthera sessilis* respectively. Maximum weed growth was observed between 14 DAT and 63 DAT. All the growth parameters of rice plant were decreased significantly between 14 DAT and 63 DAT. Panicle and grain production were started after 56 DAT and these were increased gradually upto 90 DAT. During panicle and grain production, growth of weeds was limited. Limited weed growth reduced further adverse effect on grain production.

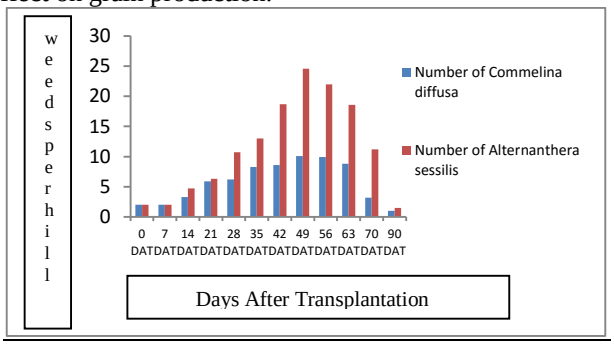

Figure 10 : Number of weeds per hill of rice

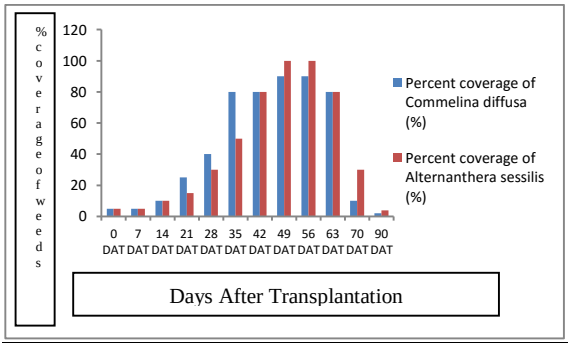

Figure 11: Percent coverage of weeds (%)

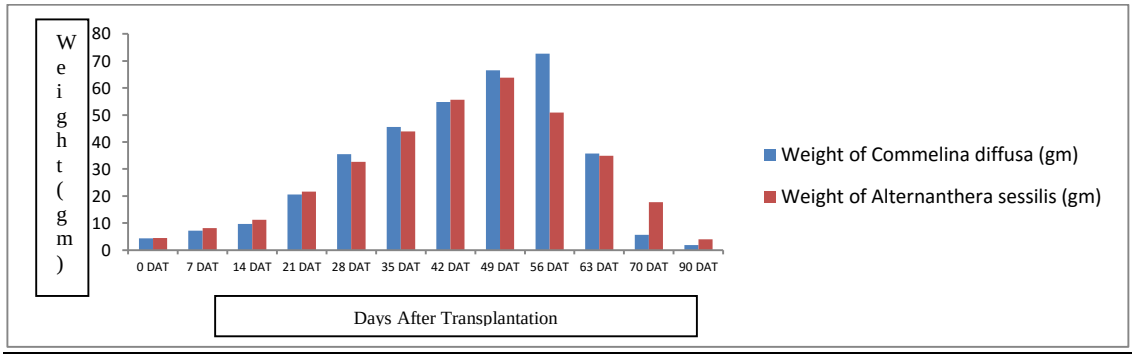

Figure 12 :Weight of weeds (gm)per hill of rice plant

3.5.Biochemical study:

Biochemical study also reveals competition effects between two plants. Weekly biochemical study was not performed in our study. Chlorophyll, protein and catalase activity were estimated after 0 DAT, 28 DAT and 56 DAT (Table 4). Chlorophyll plays a pivotal role for photosynthesis in plants. Reduction in chlorophyll content signifies less photosynthesis and fewer yields. Chlorophyll content of rice plant was slightly increased (1.07%) after 28 DAT and 56 DAT in weed free condition. Chlorophyll content of rice plant was gradually decreased by 9.78% and 14.96% respectively after 28 DAT and 56 DAT when rice plant was challanged with *Commelina diffusa*. Reduction by 11.97% and 15.87% was observed after 28 DAT and 56 DAT respectively when rice was competed with *Alternanthera sessilis*. Chlorophyll content of Commelina *diffusa* was incresed by 6.26% and 10.28% after 28 DAT and 56 DAT respectively. Chlorophyll content of *Alternanthera sessilis* was increased by 6.12% and 11.15% after 28 DAT and 56 DAT when it was competed with rice plant (Figure 13).

Table 4: Results of Biochemical study

	Chlorophyll content (mg/gm of Fresh Weight)			**Protein content (µg/gm of Fresh Weight)**			**Catalase activity (U/L)**		
Biochemical result of Rice and Weeds	0 DAT	28 DAT	56 DAT	0 DAT	28 DAT	56 DAT	0 DAT	28 DAT	56 DAT
Rice control	1.872	1.892	1.892	202	198	192	5000	5116	5112
Biochemical result of Rice after competition with *Commelina diffusa*	1.872	1.689	1.592	202	192	189	5000	4995	4980
Biochemical result of *Commelina diffusa* after competition with Rice	1.342	1.426	1.48	278	270	268	5960	6180	6700
Biochemical result of Rice after competition with *Alternanthera sessilis*	1.872	1.648	1.575	202	190	188	5000	4995	4980
Biochemical result of *Alternanthera sessilis* after competition with Rice	1.274	1.352	1.416	375	368	368	6000	6114	6570

Protein content of rice plant was decreased by 3.03% and 4.04% after 28 DAT when it was competed with

Commelina diffusa and *Alternanthera sessilis* respectively. Only 2% change in protein content was observed after 56 DAT of competition. Weed did not affect the protein content of rice plant. Protein content of *Commelina diffusa* and *Alternanthera sessilis* were not significantly changed during competition with rice (Figure 14).

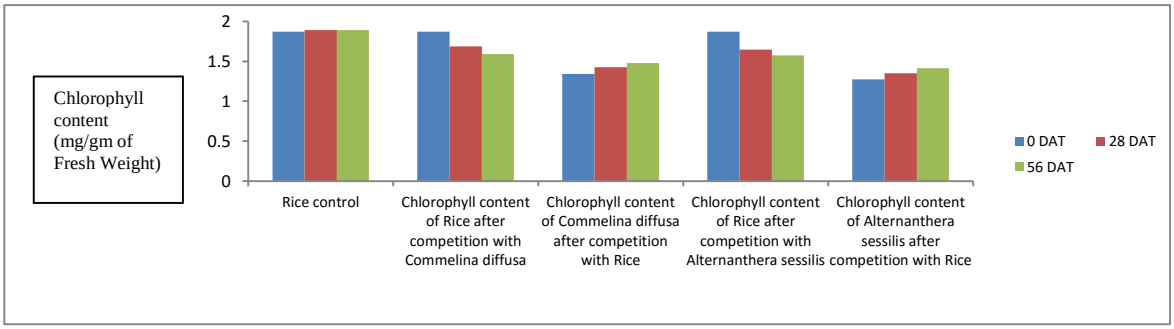

Figure13. Chlorophyll content of Rice and weeds (mg/gm of Fresh Weight)

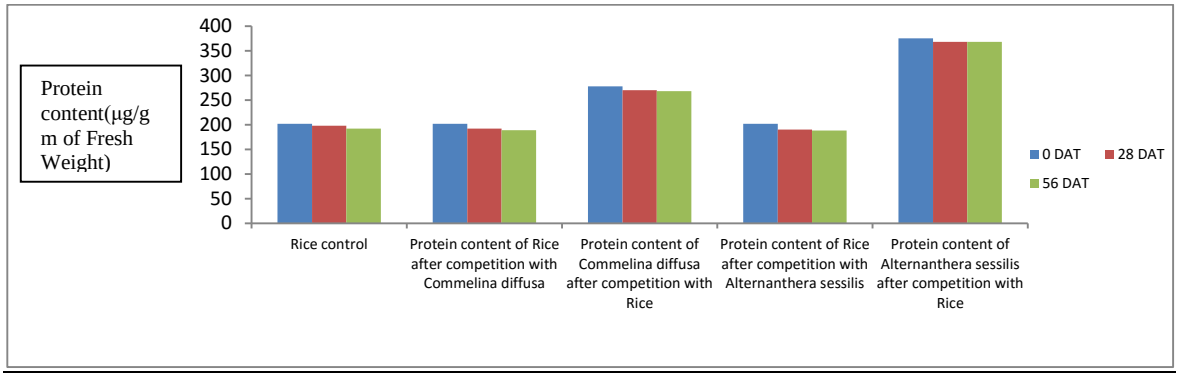

Figure14. Protein content of Rice and weeds (µg/gm of Fresh Weight)

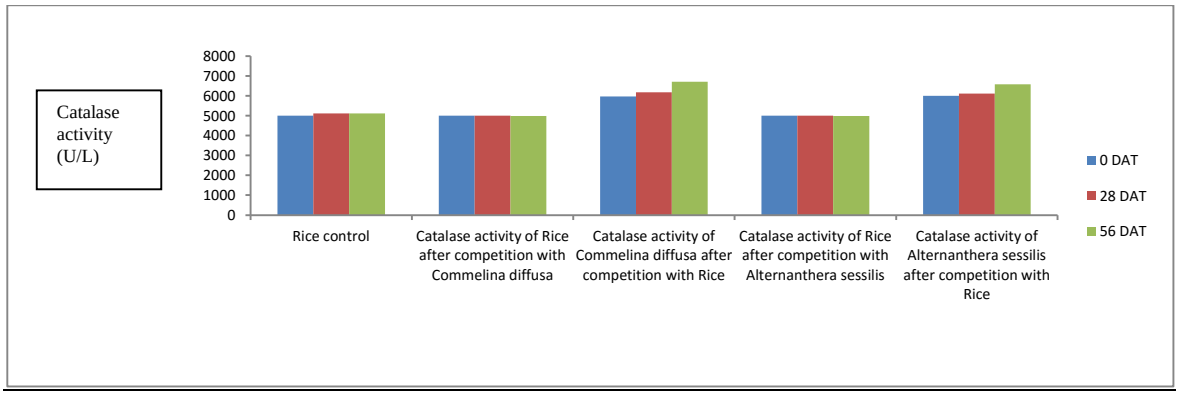

Figure15. Estimation of Catalase activity (U/L)

Catalase converts toxic hydrogen peroxide into harmless water. Increasing level of catalase indicates generation of Reactive Oxygen Species (ROS) in cultured cells or tissues [16]. Catalase activity of rice was not significantly changed in weed-free condition and weedy condition. Only 2.32% change in rice plant was observed in weed-free condition where as practically no change was observed during competition with weeds.Catalase activity was significantly changed in weeds. Catalase activity of *Commelina diffusa* was increased by 3.69% and 12.42% after 28 DAT and 56 DAT respectively, while it was competed with rice. Lesser effect (1.9% and 9.5%) was observed when *Alternanthera sessilis* was challenged with rice. These results clearly indicated that ROS generation was started in weeds after 56 DAT. It triggered the death of *Commelina diffusa* and *Alternanthera sessilis* after 63

DAT. Results revealed that number of weeds, percentage of weeds and weight of weeds were decreased drastically after 63 DAT (Figure 15).
Rice-weed competition affected catalase activity and chlorophyll content, but not the protein content of weed and rice. Biochemical study clearly showed the reason of reduction of weeds after 63 DAT. Plants donot allow any competitor during panicle and grain production.

4. Conclusion

In vitro study of competition clearly allows a competitor with rice at a time. No other co-competitor interferes in this competition. When competition takes place in agricultural field, it is very hard to control other weeds for growth. All of the morphological and biochemical studies showed that *Alternanthera sessilis* was more competitor than *Commelina diffusa*. Crop productivity and plant biomass were found maximally in weed-free condition, where as these were reduced to some extent due to competition with *Commelina diffusa* and *Alternanthera sessilis*. Maximum weed growth was observed between 14 DAT and 63 DAT, which revealed that it was a crucial time for weed management. Catalase activity showed that weeds were also challenged with rice plant and rice plant didnot allow any unwanted growth during panicle and crop production.

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