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Correlation and Path Analysis of Yield and Related Traits of Upland Rice Genotypes across Weeding Regimes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This investigation was carried out at International Institute of Tropical Agriculture IITA, Ibadan, Nigeria to estimate correlation coefficients of yield and associated traits of thirty-six upland rice lines and the effect of these attributes in four weeding regimes. The weeding regimes were: weed free, weeding twice (21 and 42 days after sowing (DAS), weeding once at 42 DAS only, and weeding once at 21 DAS only, laid out in an alpha lattice design replicated two times. Correlation analysis indicated that yield was significantly and positively associated with panicle length, panicle number and 100 seed weight in both years. There was also a highly significant negative correlation between weed dry matter at all the sampling periods and number of tillers, plant height at maturity in 2011 and number of panicles and panicle length in 2012. Weed dry matter was negatively correlated with grain yield ($P < 0.01$) in both years clearly explaining the adverse effect of weed on the yield of rice. Path analysis revealed that days to 50% flowering, 100 seed weight, number of panicles and panicle length had direct positive effect on yield across the weeding regimes. Hence, selection based on these traits could help bring simultaneous improvement of yield and yield

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attributes. For further breeding activities, more emphasis should be given to 100 seed weight, days to 50% flowering, number of panicles and panicle length as they showed high correlation in addition to maximum direct positive effects on yield.

Keywords: Correlation; upland rice; weeding regime; yield; path analysis.

1. INTRODUCTION

Rice is an important food crop in Nigeria, West Africa and the world. Global world production of milled rice rose from 448.2 million metric tons in 2008 to 504.17 million metric tons in 2021 [1]. This shows that this cereal crop is of utmost importance as it is consumed by various homes on daily basis. Rice is the most important grain with regards to human nutrition and caloric intake. Direct selection based on yield only is difficult in breeding because yield is a polygenic character influenced by other traits [2,3,4]. Path analysis is a method that permits the partitioning of correlation coefficients into its components, one being the path coefficient measuring the direct effect of a predictor variable upon its response variable and the second being the indirect effect of a particular predictor variable upon the response variable through another predictor variable [5,6]. Some authors have reported association between yield and its component traits in rice and other cereals such as Basavarja et al., [5] for days to 50% flowering, panicle length, number of panicles, number of productive tillers. Dumlipinar et al., [7] for grain filling period, panicle number, days to maturity and plant height in oat varieties. Agbo and Obi [2], also reported that fertile spikelets was the most important factor that increased yield also with number of tillers per plant having direct and moderate positive effect on yield, Kumar and Kannan Bapu, [8] for number of tillers per plant. To ensure food security especially with the rapidly increasing population, there is a need to exploit various areas for continuous improvement of this crop.

The objectives of this research were:

(1) To estimate Pearson's correlation coefficients between grain yield and associated traits for upland rice lines.

(2) To investigate direct and indirect effects of attributes on the rice yield.

2. MATERIALS AND METHODS

Field experiment was carried out in rainfed conditions for two cropping season (2011 and 2012) at International Institute of Tropical Agriculture (IITA), Ibadan. Ibadan is in South West Nigeria (Long. 3°54; Lat 7°30 243m asl). The location is characterized by bimodal rainfall distribution. An alpha lattice design replicated two times was used in this study. The weeding regimes were weeding once at 21 days after sowing (DAS), weeding once at 42 DAS, weeding twice (21 and 42 DAS), and weed free, while the rice genotypes were planted on each plot. The weed free was kept free of weeds in by hand weeding. The plot size was 1 m x 1 m (1 m^2) with a spacing of 20 cm x 20 cm inter and intra row. Each replication had 4 blocks of 9 plots, giving a total of 36 plots in each replication and 288 plots on the whole. Thirty-six lines were used in this study as shown below:

1. ART29-11-136-1-1	19. ART27-134-1-2-B-B-B
2. ART29-11-136-1-2	20. ART29-11-505-B-B
3. ART29-11-26-B-B	21. ART27-145-2-1-B-B-B
4. ART27-190-1-1-B-B-B	22. ART29-11-457-B-B
5. ART29-11-440-B-B	23. ART29-11-164-B-B
6. ART27-10-1-1(2)-B-B-B	24. ART27-79-1-3-B-B-B
7. ART29-11-288-B-B	25. ART27-26-3-1-B-B
8. ART29-11-327-B-B	26. ART26-25-1-B-B
9. ART29-11-356-B-B	27. ART29-11-52-8-B-B
10. ART29-11-161-B-B	28. ART29-11-460-B-B
11. NERICA 14	29. NERICA 1
12. ART27-105-1-1-B-B-B	30. CG 14
13. ART29-11-519-B-B	31. ART29-11-148-B-B
14. ART29-11-530-B-B	32. ART29-11-233-B-B
15. ART29-11-118-B-B-B	33. ART29-11-57-B-B
16. ART27-12-1-2(2)-B-B-B	34. ART27-142-2-1-B-B-B
17. ART29-11-505-B-B	35. ART29-11-69
18. ART29-11-444-B-B	36. AC103549

Rice was seeded in July 2011 and May 2012 growing season. Five seeds were sown per hole and later thinned to 2 seedlings per stand to give a total plant population of 500,000 plants per hectare. All plots received 200 kg/ha of NPK 15: 15: 15 as basal application. 100kg/ha of Urea was applied as nitrogen source in two equal splits (50 kg/ha of urea (46% N) at 21- 30 days after sowing (DAS) and another 50kg/ha of urea (46% N) at 42- 50 DAS [9,10]. The morphological and yield traits measured include vigour at 15 and 30 days after sowing (DAS), plant height at 21 DAS, 42 DAS and at maturity, number of tillers at 42 DAS, chlorophyll content using SPAD 502 meter, transmitted photosynthetically active

radiation (PAR), light interception (LI), weed density and dry matter at 21 DAS, 42DAS and at maturity, days to 50% flowering, days to 85% maturity, panicle length, panicle number, grain yield and 100 seed weight. Analysis of variance was carried out using Statistical Analysis System (SAS 9.2). Differences between two treatments was compared with T-test based on Standard Error of Difference (SED). Correlation coefficient was calculated using Statistical Package for the Social Sciences, (SPSS) version 16 to assess the inter relationships between yield and associated traits in the rice lines. Path coefficient analysis was used to partition the correlation coefficients into its direct and indirect effects, so that the contribution of each character to yield could be estimated.

3. RESULTS AND DISCUSSION

3.1 Inter - Relationships between Yield and Associated Traits

In 2011, yield was strongly and positively correlated with 100 seed weight, panicle number and panicle length. This means that the longer panicles which were more in number and the heavier seeds gave more yield. Number of days to 50% flowering, days to 85% maturity and plant height at maturity were positively correlated with yield although this was not significant. This was why the tall, late flowering and late maturing genotypes had more yield. Weed biomass at 21 DAS was strongly and negatively correlated with yield. Weed biomass at 42 DAS and at maturity was also negatively correlated with yield although this was not significant (Table 1). This means that the lower the weed pressure, the better the yield. This result agrees with Ekeleme et al., [11], Rodenburg et al., [12]. Plant height at maturity was also strongly and negatively correlated with weed biomass at 21 DAS, 42 DAS and at maturity. This also agrees with Rodenburg et al., [12]. This explains the importance of plant height in weed suppressive ability. In 2012, yield was strongly and positively correlated with 100 seed weight and panicle number (Table 2). Number of days to 50% flowering and number of days to 85% maturity were negatively correlated with yield. This result differs from the previous year's result because weed pressure which was more in 2011 delayed flowering and maturity. Weed biomass was strongly and negatively correlated with yield at 21 DAS and at maturity. The lower the weed biomass, the higher the yield. Weed biomass at maturity was strongly and negatively correlated with panicle number, panicle length and plant height at maturity (Table 2). This result agrees with Saito et al., [13]. In both years, tillering ability was strongly and negatively correlated with weed dry weight. (Tables 1 and 2). This result does not agree with Anwar et al., [14] who observed that tillering ability at both early and late stages were strongly positively correlated with weed dry weight but agrees with Saito et al., [13]. Ni et al., [15] also confirmed weak relationship between tillering ability and weed competitiveness, while strong relationships were reported by others [16,17]. Similarly, Saito et al., [13] observed that weed biomass averaged over two seasons was negatively correlated with growth vigour which was not the case in the experiment under study. Rodenburg et al., [12] in an experiment on weed competitiveness of lowland NERICA varieties observed that weedy yield negatively correlated with weed biomass at harvest and this agrees with the result obtained from this experiment in both years.

3.2 Path Analysis

Path analysis is a method that permits the partitioning of correlation coefficients into its components, direct and indirect effect of a particular predictor variable upon the response variable through another predictor variable [5]. This partitioning of correlation into direct and indirect effects is to get the actual contribution of each character to yield. In this study, the combined analysis of traits was done for each weeding regime to know the actual association and relationship of characters with regards to yield.

Weed Free: The combined path coefficient analysis in weed free showed that panicle length and number of days to 50% flowering had positive direct effect on yield. Other traits with positive direct effect include plant height at 42 DAS and number of panicles. 100 seed weight had direct negative effect on yield but its indirect positive effect through number of tillers and number of panicles shows that it contributed immensely to yield (Table 3).

Weeding Once only at 42 days after sowing (DAS): The result of the combined analysis showed that number of days to 50% flowering had the highest direct positive effect on yield followed by plant height at 42 DAS. Other traits with direct positive effect include panicle length and 100 seed weight (Table 4).

Table 1. Combined Pearson's correlation coefficient among different traits of rice and weed 2011

	Yld	100gwt	PANno	PANlgt	50%Flw	85%Mat	WDwt21	WDwt42	WDwtMt	V15DAS	V30DAS	PH21	PH42	PHMat
100gwt	0.318**													
PANno	0.174*	0.266**												
PANlgt	0.175*	0.200**	0.279**											
50%Flw	0.041	-0.161*	0.146*	0.073										
85%Mat	0.041	-0.124	0.061	0.170*	.838**									
WDwt21	-.251**	-.260**	-.366**	-0.049	0.095	0.03								
WDwt42	-0.015	-0.419**	-.653**	-0.225*	.174*	0.136	.362**							
WDwtMt	-0.079	-.353**	-.614**	-0.202*	-0.137	-.221**	0.08	.243**						
V15DAS	-0.09	-0.107	-0.084	0.028	.146*	0.096	.141*	.238**	0.067					
V30DAS	-0.11	-.273**	-0.168*	-0.066	.161*	0.129	.294**	.351**	.297**	.501**				
PH21	-0.139	-0.038	-.351**	-0.006	-.192**	-0.099	.305**	0.128	-.157*	0.014	0.084			
PH42	-0.05	-0.001	-.348**	0.056	-.291**	-.224**	.295**	.262**	-0.104	-0.023	-.131*	.611**		
PHMat	0.144	0.269**	0.400**	0.647**	0.084	0.171*	-.314**	-.413**	-.437**	-0.157*	-.331**	0.004	0.07	
TIL42	-0.025	0.081	0.113	-0.056	-0.062	0.044	-.197**	-.350**	-.308**	-.236**	-.411**	.127*	0.11	.283**

*** Correlation is significant P< 0.01 level.*

** Correlation is significant P =0.05 level.*

Yld- Grain yield ; 100gwt- 100 seed weight; PANno- number of panicles; PANlgt- panicle length-; 50%Flw- days to 50% flowering; 85%Mat- days to 85% maturity; WDwt21- weed dry matter 21 DAS;- WDwt42- weed dry matter 42 DAS; WDwtMt- weed dry matter at maturity, V15DAS- seedling vigour at 15 DAS; V30DAS- vigour at 30 DAS; PH21- plant height at 21 DAS; PH42- plant height at 42 DAS; PHMat- plant height at maturity; TIL42- number of tillers at 42 DAS.

Table 2. Combined Pearson's correlation coefficient among different traits of rice and weed 2012

	Yld	100gwt	PANno	PANlgt	50%Flw	85%Mat	WDwt21	WDwt42	WDwtMt	V15DAS	V30DAS	PH21	PH42	PHMat
100gwt	0.248**													
PANno	0.186**	-0.341**												
PANlgt	0.073	-0.296**	0.190**											
50%Flw	-0.071	-0.557**	0.248**	0.121*										
85%Mat	-0.117*	-0.530**	0.271**	0.099	0.767**									
WDwt21	-.197**	-0.035	-0.282**	-0.049	0.140*	-0.036								
WDwt42	-0.05	0.096	-0.055	0.106	-0.178**	-0.034	0.01							
WDwtMt	-0.251**	0.11	-0.315**	-0.161*	-0.027	-0.075	0.375**	0.102						
V15DAS	-0.087	0.158**	-0.248**	-0.192**	-0.031	-0.008	0.11	0.049	0.312**					
V30DAS	0.001	0.202**	-.192**	-0.246**	0.146*	0.057	0.221**	0.022	0.344**	0.465**				

	Yld	100gwt	PANno	PANlgt	50%Flw	85%Mat	WDwt21	WDwt42	WDwtMt	V15DAS	V30DAS	PH21	PH42	PHMat
PH21	-0.096	-0.289**	0.138*	0.258**	-0.012	0.02	0.087	-0.011	-0.200**	-0.466**	-0.527**			
PH42	-0.076	-0.382**	0.149*	0.545**	-0.130*	-0.033	-0.125	.317**	-0.147**	-0.287**	-0.557**	0.448**		
PHMat	0.033	-0.422**	0.226**	0.672**	0.04	-0.006	-0.083	-0.097	-0.108	-0.208**	-0.412**	0.299**	0.694**	
TIL42	0.093	-0.148*	0.211**	0.024	0.158**	-0.008	-0.136*	-0.580**	-0.300**	-0.346**	-0.217**	0.252**	-.173**	.121*

*** Correlation is significant P< 0.01 level.*

** Correlation is significant P =0.05 level.*

Yld- Grain yield ; 100gwt- 100 seed weight; PANno- number of panicles; PANlgt- panicle length-; 50%Flw- days to 50% flowering; 85%Mat- days to 85% maturity; WDwt21- weed dry matter 21 DAS;- WDwt42- weed dry matter 42 DAS; WDwtMt- weed dry matter at maturity, V15DAS- seedling vigour at 15 DAS; V30DAS- vigour at 30 DAS; PH21- plant height at 21 DAS; PH42- plant height at 42 DAS; PHMat- plant height at maturity; TIL42- number of tillers at 42 DAS.

Table 3. Path coefficient of combined analysis showing direct and indirect effects of the characters on yield in WEED FREE (2011 &2012)

	V15 DAS	V30 DAS	PH21 DAS	PH42 DAS	PHMAT	TIL42 DAS	PAR	LI	50% FLW	85% MAT	PANLGT	PAN NO	100SWT	Geno corr
V15DAS	**-.277**	-0.049	0.231	-0.059	0.118	0.054	-.022	0	0.087	-0.117	0.000	0.026	-0.010	-0.020
V30DAS	-.131	**-0.104**	0.278	-0.188	0.272	-0.023	-.002	0	0.148	-0.160	-0.073	0.077	0.028	0.121
PH21DAS	0.094	0.042	**-0.684**	0.186	-0.148	-0.006	0.023	0	-0.003	-0.054	0.141	-0.009	0.034	-0.385
PH42DAS	0.049	0.059	-0.380	**0.335**	-0.545	0.075	0.036	0	-0.077	0.042	0.351	-0.019	-0.008	-0.084
PHMAT	0.050	0.043	-0.154	0.277	**-0.658**	0.059	0.073	0	-0.003	-0.023	0.403	0.014	-0.011	0.069
TIL42DAS	0.101	-0.016	-0.029	-0.170	0.264	**-0.148**	0.020	0	0.132	-0.133	-0.208	0.044	0.052	-0.090
PAR	-.018	-0.001	0.045	-0.034	0.138	0.009	**-.347**	0	-0.064	0.044	-0.023	-0.034	0.027	-0.259
LI	0.018	0.001	-0.045	0.034	-0.138	-0.009	0.347	**0**	0.064	-0.044	0.023	0.034	-0.027	0.259
50%FLW	-.070	-0.045	0.006	-0.075	0.006	-0.057	0.065	0	**0.344**	-0.412	0.163	0.073	0.056	0.054
85%MAT	-.075	-0.039	-0.085	-0.033	-0.035	-0.046	0.035	0	0.329	**-0.432**	0.198	0.071	0.056	-0.056
PANLGT	0.000	0.013	-0.160	0.195	-0.440	0.051	0.013	0	0.093	-0.142	**0.603**	0.020	0.003	0.248
PAN NO	-.041	-0.045	0.036	-0.037	-0.053	-0.037	0.067	0	0.142	-0.172	0.067	**0.177**	0.011	0.114
100SWT	-.021	0.021	0.173	0.020	-0.055	0.056	0.068	0	-0.142	0.177	-0.015	-0.015	**-0.136**	0.132

V15DAS—Seedling vigour at 15 DAS, V30DAS—Vigour at 30 DAS, PH21DAS—Plant height at 21 DAS, PH42DAS—Plant height at 42 DAS, PHMAT—Plant height at maturity, TIL42DAS—Number of tillers at 42 DAS, PAR—Photosynthetically active radiation, LI—Light interception, 50%FLW—Days to 50% flowering, 85%MAT—Days to 85% maturity, PANLGT—Panicle length, PAN NO—Average number of panicles per plot, 100SWT—average weight of 100 seeds per plot. Geno corr—Genotypic correlation for each character.

Table 4. Path coefficient of combined analysis showing direct and indirect effects of the characters on yield in WEEDING ONCE AT 42 DAS only (2011 &2012)

	V15DAS	V30DAS	PH21DAS	PH42DAS	PHMAT	TIL42DAS	WDWT21	WDWT42	WDWTMAT	PAR	LI	50% FLW	85% MAT	PANLGT	PAN NO	100SWT	Genocorr
V15DAS	**-.500**	0.057	0.033	-0.01	-,0004	0.083	0.026	-0.019	-0.101	-.028	0	-0.143	0.144	-.016	0.0074	0.028	-.4033
V30DAS	-.198	**0.130**	0.116	-0.36	0.319	0.043	0.025	-0.020	-0.154	-.040	0	0.066	-.036	-.023	-0.015	0.043	-.1045
PH21DAS	0.072	-.073	**-0.200**	0.359	-0.276	0.003	-0.013	-0.008	0.189	0.027	0	-0.001	0.005	0.009	0.009	-0.039	0.0514
PH42DAS	0.010	0.081	-0.127	**0.590**	-0.555	0.017	-0.019	-0.001	0.159	0.021	0	0.024	0.024	0.062	0.0081	-0.014	0.1216
PHMAT	-.0003	-.054	-0.074	0.417	**-0.790**	0.057	-0.050	0.0025	0.144	0.018	0	0.122	-.045	0.068	0.0171	-0.033	-.2009
TIL42DAS	0.17	-.025	0.003	-0.04	0.198	**-0.200**	0.025	0.0352	0.211	0.028	0	0.065	-.039	-.018	-0.014	0.013	0.3806
WDWT21	0.057	-.016	-0.013	0.057	-0.192	0.027	**-0.210**	0.0065	-0.096	0.010	0	0.250	-.104	0.054	-0.008	0.042	-.1326
WDWT42	-.095	0.028	-0.017	0.007	0.021	0.084	0.014	**-0.090**	-0.185	-.046	0	-0.006	0.036	0.016	0.0069	-0.014	-.2445
WDWTMAT	-.084	0.037	0.072	-0.17	0.207	0.086	-0.036	-0.032	**-0.551**	-.035	0	0.006	0.025	0.011	-0.0004	0.055	-.4107
PAR	-.110	0.045	0.048	-0.1	0.119	0.052	0.017	-0.037	-0.1627	**-0.12**	0	-0.282	0.219	-.018	0.0009	0.043	-.2869
LI	0.110	-.045	-0.048	0.105	-0.120	-0.052	-0.017	0.0366	0.1627	0.119	**0**	0.282	-0.219	0.018	-0.009	-0.043	0.2869
50%FLW	0.099	0.013	0.004	0.022	-0.144	-0.022	-0.077	0.0008	-0.0049	0.050	0	**0.670**	-0.429	0.059	-0.013	-0.022	0.2025
85%MAT	0.136	0.01	0.002	-0.03	-0.073	-0.018	-.0439	0.0069	0.0278	0.054	0	0.589	**-.500**	0.043	-0.019	-0.027	0.1704
PANLGT	0.051	0.022	-0.014	0.262	-0.383	0.028	-.0792	-0.011	-0.0447	0.016	0	0.28	-0.150	**0.141**	-0.017	0.036	0.0944
PAN NO	0.063	0.036	0.035	-0.09	0.2468	-0.057	-.0285	0.0119	-0.0074	0.002	0	0.164	-.165	0.042	**-0.05**	0.097	0.2965
100SWT	-0.07	0.031	0.045	-0.05	0.1401	-0.016	0.0469	0.0071	-0.1638	-.028	0	-0.08	0.072	0.028	-0.029	**0.185**	0.0295

V15DAS—Seedling vigour at 15 DAS, V30DAS—Vigour at 30 DAS, PH21DAS—Plant height at 21 DAS, PH42DAS—Plant height at 42 DAS, PHMAT—Plant height at maturity, TIL42DAS—Number of tillers at 42 DAS, WDWT21—Weed dry weight (g) at 21 DAS,WDWT42—Weed dry weight (g) at 42 DAS, WDWTMAT—Weed dry weight (g) at Maturity, PAR—Photosynthetically active radiation, LI—Light interception, 50%FLW—Days to 50% flowering, 85%MAT—Days to 85% maturity, PANLGT—Panicle length, PAN NO—Average number of panicles per plot, 100SWT—average weight of 100 seeds per plot Geno corr—Genotypic correlation for each character.

Table 5. Path coefficient of combined analysis showing direct and indirect effects of the characters on yield in WEEDING TWICE (2011 & 2012)

	V15DAS	V30DAS	PH21DAS	PH42DAS	PHMAT	TIL42DAS	WDWT21	WDWT42	WDWTMAT	PAR	LI	50%FLW	85%MAT	PANLGT	PAN NO	100SWT	Geno corr
V15DAS	**0.300**	-.268	-0.061	0.021	0.001	0.127	-0.018	-0.071	-0.038	-0.012	0	-.091	0.11	-0.011	-.055	0.021	-.044
V30DAS	0.199	**-.410**	-0.096	0.082	0.159	0.065	-0.018	-0.027	-0.010	-0.004	0	0.081	-0.103	-0.061	0.011	-0.07	-.199
PH21DAS	-.069	0.144	**0.270**	-0.127	-0.167	0.009	-0.082	-0.177	-0.029	-0.007	0	-.055	0.063	0.059	-0.01	0.001	-.178
PH42DAS	-.032	0.170	0.174	**-0.200**	-0.394	0.045	-0.026	-0.096	-0.014	-0.007	0	-.091	0.086	0.166	0.004	0.063	-.148
PHMAT	-.004	0.129	0.089	-0.154	**-0.500**	0.041	0.032	-0.036	0.011	0.0107	0	0.039	-0.051	0.261	0.032	0.054	-.045
TIL42DAS	-.178	0.123	-0.011	0.041	0.096	**-0.210**	0.015	0.119	0.044	0.0254	0	0.213	-0.229	-0.068	0.075	-0.15	-.095
WDWT21	0.028	-.039	0.117	-0.027	0.084	0.017	**-0.189**	-0.045	-0.005	-0.018	0	-0.05	0.055	-0.021	-.027	0.004	-.121
WDWT42	0.061	-.031	0.134	-0.053	-0.052	0.072	-0.024	**-0.352**	-0.016	-0.001	0	0.037	0.005	-0.009	0.082	0.026	-.120
WDWTMAT	0.078	-.028	0.052	-0.019	0.036	0.065	-0.006	-0.038	**-0.150**	-0.001	0	-.282	0.313	-0.034	-.147	0.086	-.069
PAR	0.033	-.014	0.019	-0.014	0.051	0.052	-0.032	-0.002	-0.002	**-0.11**	0	-.238	0.235	-0.073	-.125	0.055	-.162

	V15DAS	V30DAS	PH21DAS	PH42DAS	PHMAT	TIL42DAS	WDWT21	WDWT42	WDWTMAT	PAR	LI	50%FLW	85%MAT	PANLGT	PAN NO	100SWT	Geno corr
LI	-.033	0.014	-0.019	0.014	-0.051	-0.052	0.032	0.002	0.002	0.106	**0**	0.238	-0.235	0.073	0.125	-0.05	0.162
50%FLW	-.047	0.057	-0.026	0.031	-0.034	-0.079	0.017	-0.023	0.071	0.044	0	**0.58**	-0.605	0.095	0.204	-0.16	0.004
85%MAT	-.053	-.066	-0.027	0.027	-0.04	-0.078	0.017	0.003	0.072	0.039	0	0.553	**-0.63**	0.102	0.191	-0.19	-.081
PANLGT	-.010	0.073	0.047	-0.096	-0.386	0.043	0.012	0.009	0.015	0.023	0	0.161	-0.19	**0.340**	0.028	0.006	0.074
PAN NO	-.053	-.014	-0.009	-0.003	-0.052	-0.052	0.017	-0.093	0.069	0.043	0	0.381	-0.39	0.031	**0.310**	-0.100	0.083
100SWT	0.020	0.089	0.0006	-0.038	-0.085	0.097	-.0001	-0.028	-0.039	-0.018	0	-.291	0.372	0.006	-.097	**0.320**	0.309

V15DAS—Seedling vigour at 15 DAS, V30DAS—Vigour at 30 DAS, PH21DAS—Plant height at 21 DAS, PH42DAS—Plant height at 42 DAS, PHMAT—Plant height at maturity, TIL42DAS—Number of tillers at 42 DAS, WDWT21—Weed dry weight (g) at 21 DAS,WDWT42—Weed dry weight (g) at 42 DAS, WDWTMAT—Weed dry weight (g) at Maturity, PAR—Photosynthetically active radiation, LI—Light interception, 50%FLW—Days to 50% flowering, 85%MAT—Days to 85% maturity, PANLGT—Panicle length, PAN NO—Average number of panicles per plot, 100SWT—average weight of 100 seeds per plot Geno corr—Genotypic correlation for each character.

Table 6. Path coefficient of combined analysis showing direct and indirect effects of the characters on yield in WEEDING ONCE AT 21 DAS Only

	V15 DAS	V30 DAS	SPAD	PH21 DAS	PH42 DAS	PHMAT	TIL42 DAS	WDWT 21DAS	WDWT 42DAS	WDWT MAT	PAR	LI	PAN NO	PANLGT	50% FLW	85% MAT	100SWT	Geno corr
V15DAS	**0.040**	0.153	-0.02	0.011	0.159	-0.050	-0.1	0.030	0.0019	-0.05	-0	0	-0.043	-0.09	0.100	-.160	-0.004	-.072
V30DAS	0.029	**0.230**	-0.02	0.01	0.185	-0.090	-0.2	-0.020	-0.0004	-0.042	-0.01	0	-0.041	-0.05	0.126	-.180	-0.003	-.058
SPAD	-.004	-0.03	**0.160**	-0.006	-.100	0.029	-0.100	-0.003	-0.008	-0.036	-0.03	0	-0.033	0.057	-.160	0.251	-0.041	-.056
PH21DAS	-.031	-0.15	0.059	**-0.020**	-0.15	0.035	0.150	-0.020	-0.003	0.0267	-0	0	0.022	0.062	-.120	0.166	-0.004	0.034
PH42DAS	-.023	-0.14	0.054	-0.008	**-.300**	0.204	0.100	0.020	-0.004	0.0131	0.014	0	0.024	0.088	-.200	0.292	-0.006	0.111
PHMAT	-.007	-0.07	0.017	-0.002	-.210	**0.280**	0.08	0.020	-0.004	0.0171	0.027	0	0.079	0.142	-0.12	0.174	-0.006	0.407
TIL42DAS	-.019	-.130	-0.040	-0.008	-.090	0.069	**0.300**	0.010	-0.002	0.0689	0.03	0	0.053	0.085	-.002	-.010	0.0324	0.385
WDWT21	-0.01	0.041	0.004	-0.003	0.040	-0.05	-0.004	**-0.100**	-0.005	-0.017	-0.01	0	-0.06	0.049	0.008	-.010	0.0026	-.173
WDWT42	-.002	0.002	0.038	-0.001	-.030	0.028	0.02	-0.020	**-0.030**	-0.016	-0	0	-0.025	0.055	-0.05	0.099	-0.011	0.074
WDWTMAT	0.022	0.097	0.058	0.004	0.039	-0.050	-0.2	-0.020	-0.005	**-0.100**	-0.02	0	-0.092	-0.09	-0.04	0.043	-0.020	-.441
PAR	0.001	0.029	0.075	-0.004	0.060	-0.110	-0.1	-0.030	-0.004	-0.034	**-.100**	0	-0.052	-0.05	0.029	-0.01	-0.022	-.347
LI	-.001	-0.03	-0.07	0.001	-.060	0.114	0.14	0.030	0.0008	0.0336	0.068	**0**	0.052	0.05	-0.03	0.007	0.0218	0.347
PAN NO	-.009	-0.04	-0.02	-0.002	-.030	0.104	0.08	0.040	0.004	0.0428	0.016	0	**0.215**	0.085	0.031	-0.03	0.0061	0.468
PANLGT	-.017	-0.04	0.039	-0.004	-.110	0.169	0.11	-0.030	-0.008	0.0376	0.014	0	0.077	**0.240**	-0.06	0.100	-0.024	0.513
50%FLW	0.015	0.104	-0.09	0.007	0.211	-0.120	-0.004	-0.0036	0.0061	0.0141	-0.01	0	0.024	-0.05	**0.280**	-0.35	0.0261	0.061
85%MAT	0.017	0.105	-0.1	0.006	0.221	-0.130	0.01	-0.0043	0.0086	0.0109	-.003	0	0.017	-0.06	0.248	**-.400**	0.0357	-.013
100SWT	0.001	0.005	0.057	-.0004	-0.020	0.016	-0.1	0.0028	-0.003	-0.017	-0.01	0	-0.011	0.049	-0.06	0.123	**-0.110**	-.059

V15DAS—Seedling vigour at 15 DAS, V30DAS—Vigour at 30 DAS, PH21DAS—Plant height at 21 DAS, PH42DAS—Plant height at 42 DAS, PHMAT—Plant height at maturity, TIL42DAS—Number of tillers at 42 DAS, WDWT21—Weed dry weight (g) at 21 DAS,WDWT42—Weed dry weight (g) at 42 DAS, WDWTMAT—Weed dry weight (g) at Maturity, PAR—Photosynthetically active radiation, LI—Light interception, 50%FLW—Days to 50% flowering, 85%MAT—Days to 85% maturity, PANLGT—Panicle length, PAN NO—Average number of panicles per plot, 100SWT—average weight of 100 seeds per plot Geno corr—Genotypic correlation for each character.

Weeding Twice: In weeding twice, Number of days to 50% flowering and panicle length had the highest direct positive effect on yield. Also, panicle number and 100 seed weight with magnitudes of 0.31 and 0.32 had direct positive effect on yield. Number of tillers had direct negative effect on yield but its indirect positive effect through plant vigour, plant height at 42 DAS and number of panicles shows its great contribution to yield (Table 5).

Weeding Once at 21 days after sowing (DAS): From Table 6, number of tillers at 42 DAS, plant height at maturity and number of days to 50% flowering had high positive direct effect on yield. Plant height at 42 DAS had negative effect but its indirect positive effects through panicle length and number of panicles shows its contribution to yield.

Light interception as an individual trait did not contribute negatively or positively to yield in all the weeding regimes. The indirect contribution of light interception through other traits had values at varying magnitudes. However, the values were very low and not up to 0.1 with the exception of positive indirect effects through number of days to 50% flowering, photosynthetically active radiation in weed free (Table 3), plant vigour at 15 DAS, plant height at 42 DAS, photosynthetically active radiation and number of days to 50% flowering in weeding once at 42 DAS (Table 4), photosynthetically active radiation, number of days to 50% flowering, panicle length and panicle number in weeding twice (Table 5). Several authors have reported that grain yield is influenced by high direct positive effects of number of tillers, number of days to 50% flowering, number of filled grains / panicle, plant height, panicle length, productive tillers, fertile spikelets, and days to maturity [5,7]. From this study, the high significant negative correlation between weed dry matter at all the sampling periods and number of tillers, plant height at maturity in 2011 and number of panicles and panicle length in 2012 clearly explains the adverse effect of weeds on the yield of rice. Yield is a polygenic character controlled by several genes. A single trait alone may not be the sole contributor to yield, other traits may directly or indirectly contribute to yield. Hence, the need for continuous work for improvement of upland rice and to ensure sustainability and food security. The path analysis from this study revealed that number of days to 50% flowering, 100 seed weight, number of panicles and panicle length had direct positive effect on yield across the weeding regimes. Hence, selection based on these traits could help bring simultaneous improvement of yield and yield attributes.

The result obtained from this study agrees with the results from previous works. This therefore indicates that if other factors are held constant, an increase in panicle length, plant height at 42 DAS, panicle number, 100 seed weight, and improving on number of days to 50% flowering will reflect in an increased yield.

4. CONCLUSION

Correlation analysis indicated that yield was significantly and positively associated with panicle length, panicle number and 100 seed weight in both years. There was also a highly significant negative correlation between weed dry matter at all the sampling periods and number of tillers, plant height at maturity in 2011 and number of panicles and panicle length in 2012. Weed dry weight was negatively correlated with yield ($P < 0.01$) in both years clearly explaining the adverse effect of weed on the yield of rice.

Path analysis revealed that number of days to 50% flowering, 100 seed weight, number of panicles and panicle length had direct positive effect on yield across the weeding regimes. Hence, selection based on these traits could help bring simultaneous improvement of yield and yield attributes.

It is therefore recommended that for further breeding activities, more emphasis should be given to plant height at 42 DAS, number of days to 50% flowering, number of panicles and panicle length as they showed high correlation in addition to maximum direct positive effects on yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. United states department of Agriculture, USDA Economic Research Service Situation and Outlook; 2021. Availabble:https://www.ers.usda.gov/webdocs/outlook
2. Agbo CU, Obi IU. Yield and yield component analysis of twelve upland rice genotypes. Agro-science. 2005;4(1):29-33.

3. Yadav SK, Suresh BG, Pandey P, Kumar B. Assessment of genetic variability, correlation and path association in rice (*Oryza sativa* L.) . J. Bio-Sci. 2010;18:1-8.
4. Akhtar LH, Pervez MA, Nasim M. Genetic divergence and inter-relationship studies in chickpea (*Cicer arietinum* L.). Pak. J. Agri. Sci. 2011;48:35-39.
5. Basavaraja T, Gangaprasad S., Kumar BM, Shilaja H. Correlation and path analysis of yield and yield attributes in local rice cultivars (*Oryza sativa* L.). Electronic J. of Plant Breeding. 2011;2(4):523-526.
6. Cyprien M, Kumar V. Correlation and path coefficient analysis of rice cultivars. Data Journal of Reliability and Statistical Studies. 2011;4(2):119-131.
7. Dumlupinar Z, Kara R, Dokuyucu T, Akkaya A. Correlation and path analysis of grain yield and yield components of some Turkish oat genotypes. Pak. J. Bot. 2012; 44(1):321-325.
8. Kumar P, Kannan Bapu JR. Character association in inter sub-specific rice hybrids involving wide compatible gene. Crop Res. 2005;30(2):208-210.
9. Oikeh SO, Nwilene FE, Agunbiade TA, Oladimeji O, Ajayi O, Semon M, Tsunematsu H, Samejima H. Growing upland rice: A production handbook. Africa Rice Center (WARDA). Cotonou, Benin. 2009;40.
10. Kamai N, Omoigui LO, Kamara AY, Ekeleme F. Guide to rice production in Northern Nigeria. International Institute of Tropical Agriculture, Ibadan, Nigeria. 2020;27.
11. Ekeleme F, Kamara AY, Oikeh SO, Omoigui LO, Amaza P, Abdoulaye T, Chikoye D. Response of upland rice cultivars to weed competition in the savannas of West Africa. Crop Protection. 2009;28:90-96
12. Rodenburg J, Saito K, Kakaı RG, Toure´ A, Mariko M, Kiepe B. Weed competitiveness of the lowland rice varieties of NERICA in the southern Guinea Savanna. Field Crops Research. 2009;114:411–418.
13. Saito K, Azoma K, Rodenburg J. Plant characteristics associated with weed competitiveness of rice under upland and lowland conditions in West Africa. Field Crops Research. 2010;116:308–317.
14. Anwar Md parvez, Juraimi AS, Man A, Puteh A, Selamat A, Begum M. Weed suppressive ability of rice (*Oryza sativa* L.) germplasm under aerobic soil condition. Aus. Journal of Crop Sc. 2010;4(9):706-717.
15. Ni H, Moody K, Robles RP, Paller EC, Lales JS. *Oryza sativa* plant traits conferring competitive ability against weeds. Weed Sci. 2000;48:200–204.
16. Fischer AJ, Ramirez HV, Gibson KD, Pinheiro SB. Competitiveness of Semi dwarf Upland rice cultivars against palisade grass (*Brachiaria brizantha*) and Signal grass (*B. decumbens*). Agron. J. 2001;93:967-973
17. Zhao DL, Atlin GN, Bastiaans L, Spiertz JH. Cultivar weed competitiveness in aerobic rice: Heritability, correlated traits, and the potential for indirect selection in weed-free environments. Crop Sci. 2006; 46(1):372–380.

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