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RESEARCH NOTE

Assessing weed competitive abilities of rice genotypes in direct-seeded rice using purple rice as model weed

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ABSTRACT

Studies were undertaken to evaluate the influence of crop-weed competition period and genotypes on crop emergence, vigour, growth, yield attributes, yield and weed growth in direct-seeded rice during rainy season (*Kharif*) 2020 at Punjab Agricultural University, Ludhiana, India. The experiment comprising four crop-weed competition period *viz*; Weedy throughout (WT), Weed free up to 15 days (WF15), Weed free up to 30 days (WF30) and weed free throughout (WF-Th) in main plots; and eight genotypes (*RYT 4004, RYT 4005, RYT 4079, RYT 4080, RYT 4081, PR 120, PR 126 and SAVA 134*) in sub-plots with 3 replications was laid out in split plot design. The competition to the crop was imposed through purple rice. It is evident that keeping the crop weed free up to 30 days recorded crop emergence, vigour, yield attributes and yield similar to that of weed free throughout treatment. Among genotypes, *SAVA 134, PR 120* and *PR 126* were found to be weed suppressive and high yielding genotypes. Although *RYT 4081* was also weed suppressive but gave the least grain yield. Among various traits, grain yield (-1.5437) exerted very high negative direct effect *fb* leaf area index (LAI) at 7 DAS (-0.9185) *fb* plant tillers at physiological maturity (-0.8908) on DMA by surrogate weed at physiological maturity. All the parameters namely; root length (7 DAS), plant height (30 DAS), plant tillers (60, 90 DAS and physiological maturity), flag leaf area, number of leaves/plant (60 DAS), DMA (30 DAS), dry matter partitioning to panicles (at anthesis), panicles/m^2 and straw yield exerted high negative indirect effect through grain yield as well as LAI (7 DAS) on surrogate weed DMA at physiological maturity.

Keywords: Crop-weed competition period, Flag leaf area (FLA), Genotypes, Physiological maturity (PM), Purple rice

Rice is one of the most important cereal crops worldwide as it serves as the basis of life for half of the global population (Khir and Pan 2019). Higher production of rice is necessary for food security. Globally, more than 50% rice area follows puddled transplanting method for cultivation of rice (Dass *et al.* 2016). But now, as a result of the looming water crisis and shortage of labour, farmers in Asia are considering dry direct-seeding as a good alternative to transplanting (Dhillon and Mangat 2018, Dhillon *et al.* 2021), where, rice crop is established by drilling the rice seeds directly in the field. It is reported that DSR saves 12-60% of irrigation water, 8-60% in labour, reduce global warming potential by 32-44%, cost of cultivation by ₹ 6436-7950/ha and results in better wheat yield (8-10%) than puddled transplanted rice (PTR) (Kumar and Ladha, 2011, Kumar and Harikesh 2018, Bhullar *et al.* 2018, Ranbir *et al.* 2019, Basavalingaiah *et al.* 2020). However, weeds are the major bottleneck in realizing the yield potential of direct-seeded rice (Dhillon *et al.* 2021a).

Transplanted rice has a greater competitive advantage over weeds that emerge after transplanting; but in direct seeding, the rice plants compete with the weeds from the time they emerge. Weeds being hardy and have profuse root and shoot growth habit, grow faster than rice and thereby check the growth of rice by severe weed crop competition in critical crop-weed competition period. Herbicide have been proven to be the most effective way in controlling weeds, but intensive herbicide use can cause environmental contamination and may increase the risk of herbicide resistance in weeds (Heap 2014). With the increased herbicide use, risk of herbicide resistance, shifting of weed flora, rising costs of production and environmental contamination are major concerns, creating an interest for exploring cultural (non-chemical) method of weed control (Chauhan 2012).

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Hence, ecological approach like selection of weed competitive genotypes is an important non-monetary practice, which can be exploited as an integrated tool for reducing herbicide costs, minimize environment degradation and delay the evolution of herbicide resistance in weeds (Dhillon *et al.* 2021b). Growing of genotypes in the presence of weeds can help to evaluate their weed competitiveness. Weed competitive genotypes have the ability to maintain higher yields despite weed competition. For this purpose, a model weed with morphologically different characters can serve better as; it will be easy to distinguish between weedy and weed free treatments and there will be ease in carrying out different crop-weed competition regimes. Purple rice (*Oryza sativa*) has already been used as a model weed for screening of genotypes for weed competitiveness in earlier studies at Internationonal Rice Research Institute (IRRI). It is an IRRI rice cultivar that is used as a boundary marker in rice plant breeding experiments as its plants are easily distinguishable from ordinary rice plants due to its burgundy foliage colour. Among the weed species *Echinochloa* spps. are the predominant grass weeds in rice. Purple rice is one of the best suited models weed for screening of weed competitiveness as a replacement to *E. crus-galli* owing to its maximum height comparable to that of *E. crus-galli*, the main weed species in rice (Bastiaans *et al.* 1997). Therefore, a study was conducted during rainy season (*Kharif*) of 2020 to screen the weed competitive potential of rice genotypes against purple rice (a surrogate weed) in direct-seeded rice.

The experiment was conducted during *Kharif* 2020 at the Research Farm, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, India [30°56' N latitude; 75°52' E longitude; 247 m altitude] located in the Indo–Gangetic Plains Region (IGPR). Climate of experimental site is characterized as sub-tropical, semi–arid with an annual rainfall of 733 mm, out of which about 80% is received from June to September. Rainfall, maximum and minimum temperatures were measured at agro–meteorological observatory of PAU, Ludhiana situated at 200 m from the experimental site. The experimental site was Typic Ustipsamment (Fatehpur sandy–loam), low in available–N (265.0 kg/ha), high in available–P (31.9 kg/ha) and medium in available–K (136 kg/ha) and organic carbon (0.42%). The soil pH and electrical conductivity were within the normal range.

The experiment was laid out in split plot design keeping four crop-weed competition periods [weedy throughout (WT), weed free up to 15 days (WF15), weed free up to 30 days (WF30) and weed free throughout (WF-Th)] in main plot and eight genotypes (*RYT 4004, RYT 4005, RYT 4079, RYT 4080, RYT 4081, PR 120, PR 126 and SAVA 134*) in sub plots. Purple rice was used as surrogate weed in this experiment to evaluate the weed competitiveness of the rice genotypes. Seeds were sown in proper moisture conditions (locally known as *vattar* DSR method or soil mulch DSR). Pre-sowing irrigation was applied in a well-prepared soil followed by shallow tillage when field reaches *vattar* (field capacity) condition and then rice sowing was done by *pora* method (when seeds are kept in a funnel, they gradually descend through the pointed ends that pierce the ground, planting themselves deeply) on June 15, 2020 at row spacing of 20 cm using a seed rate of 20 kg/ha in plots measuring 12-meter square. First post-sowing irrigation was applied 15 days after sowing. Subsequent irrigations were scheduled as per the crop demand at weekly interval. All other production and protection technologies were followed as per recommendations of Punjab Agricultural University, Ludhiana (Anonymous 2020).

Daily emergence counts until the plant population became constant were recorded from each plot, from 1 m row and emergence rate index (ERI) was calculated using formula suggested by Bartlett (1937). Ten seedlings from each replication of each plot were taken randomly at 7 and 15 DAS and seedling vigour indices (VI-2 and VI-2) were measured as suggested by Abdul-Baki and Anderson (1973).

The various dry matter partitioning indices were calculated as under:

a) **Dry matter translocation (DMT)**: The DMT during reproductive period was calculated as per following formula given by Cox *et al.*(1986):

$\text{DMT} = \text{Total DM}_{(\text{at anthesis})} - (\text{DM}_{(\text{leaf})} + \text{DM}_{(\text{culm})} + \text{DM}_{(\text{chaff})})$ at physiological maturity

Where, $\text{DM}_{(\text{leaf})}$ is the dry matter of leaves, $\text{DM}_{(\text{culm})}$ is the dry matter of culm and $\text{DM}_{(\text{chaff})}$ is the dry matter of culm at physiological maturity.

b) **Dry matter translocation efficiency (DMTE)**:

$$\text{DMTE (\%)} = \frac{\text{DMT}}{\text{dry matter at anthesis}} \times 100$$

c) **Contribution of pre-anthesis DM remobilization to grain (CDMRG)**

$$\text{CDMRG} = \frac{\text{DMT}}{\text{DM(grain)}} \times 100$$

Where, DM $_{(grain)}$ is the DM of grain at physiological maturity.

Number of panicles were counted from one meter marked row of each plot and expressed as panicle/m^2. For estimating grain yield, a net area of 7.8 m^2 (6 rows X 6.5 m) was harvested from each plot and then threshed, sun dried, winnowed, cleaned and weighed on the electronic balance. For valid comparison of different treatments, moisture content in grains was estimated using digital moisture meter (Kett's RICETER J handheld grain moisture meter). Grain yield was adjusted at 14% moisture and expressed as t/ha. For estimating straw yield, the weight of straw from each net plot was recorded three days after harvest for estimation of straw yield, which was expressed as t/ha.

Data were subjected to analysis of variance (ANOVA) using statistical software (SAS 9.3.). Treatment means were compared using Tukey's test at p d” 0.05. The path coefficient analysis was done according to the method given by Wright (1921) and elaborated by Dewey and Lu (1959).

Effect on crop

Emergence and vigour studies: Results (**Figure 1**) show that weed free treatments (*i.e.,* WF15, WF30 and WF-Th) recorded higher values for ERI, VI-I &II (at 7 and15 DAS) and leaf area index (LAI) at 7 DAS. Although at 7 DAS, LAI and VI-I and II failed to show significant differences among crop-weed competition periods. Among genotypes (**Figure 1**), *PR 120, PR 126* and *SAVA 134* consistently recorded higher values for these parameters as compared to rest of the genotypes. Data reveal that, *PR 120* recorded the highest LAI at 7 DAS, *PR 126* recorded the highest VI-I at 15 DAS while the highest VI-I & II at 7 DAS and VI-II at 15 DAS was recorded by *SAVA 134*. However, all these were statistically similar in case of ERI. The genotype *RYT 4079* recorded the least values for these parameters.

The higher values of dry matter partitioning indices were recorded in *SAVA 134* but also in *RYT*

Table 1. Effect of crop-weed competition period and genotype on dry matter partitioning indices of crop

Treatment	DMT (g/m^2)	DMTE (%)	CDMRG (%)
Crop-weed competition period			
Weedy throughout (WT)	183.7	29.51	37.8
Weed free up to 15 days (WF15)	255.1	29.45	43.6
Weed free up to 30 days (WF30)	374.1	34.32	52.6
Weed free throughout (WF-Th)	390.7	34.55	52.5
LSD (p=0.05)	61.8	NS	10.0
Genotypes			
RYT 4004 (G_1)	189.7	22.8	30.8
RYT 4005 (G_2)	201.5	26.4	30.3
RYT 4079 (G_3)	266.6	33.5	50.4
RYT 4080 (G_4)	180.6	25.9	25.4
RYT 4081 (G_5)	216.9	25.7	61.3
PR 120 (G_6)	332.7	33.1	52.2
PR 126 (G_7)	459.1	43.5	61.0
SAVA 134 (G_8)	560.2	44.6	61.3
LSD (p=0.05)	101.2	7.89	18.8

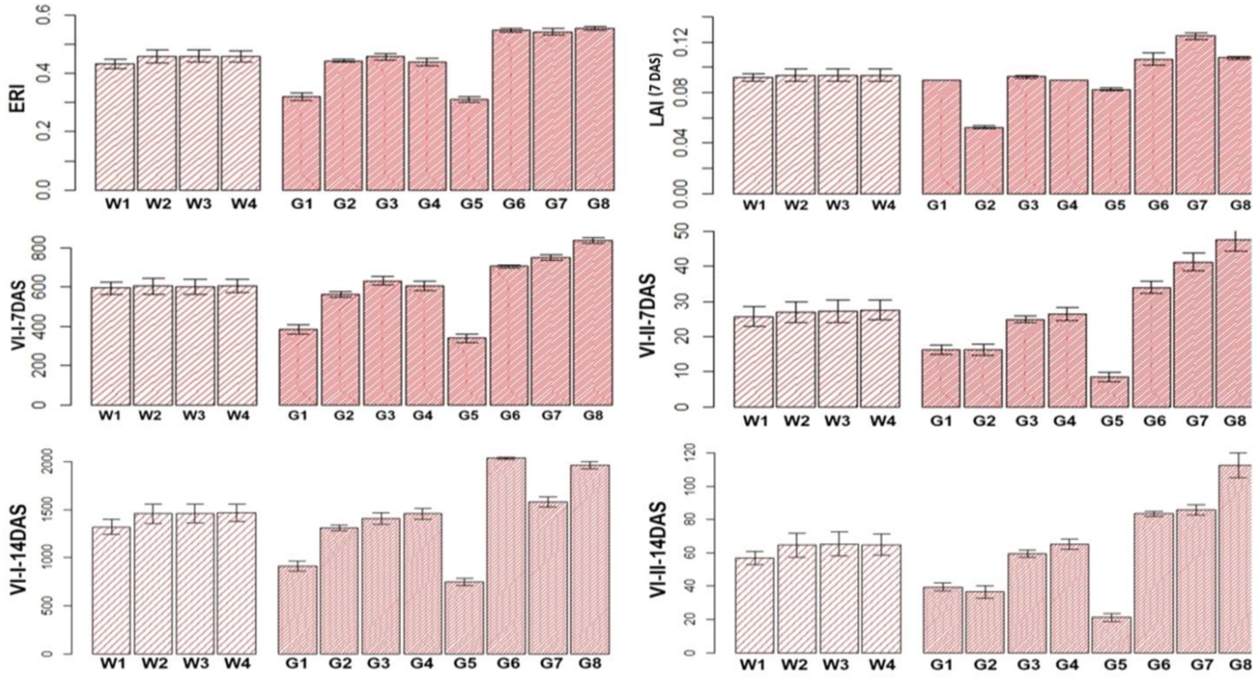

Figure 1. Effect of crop-weed competition period and genotype on emergence and vigour studies of crop

4081 in case of CDMRG (**Table 1**). It was noted that *SAVA 134* was at par with *PR 126* for DMT, DMTE, however, for CDMRG both *SAVA 134* and *RYT 4081* showed statistical parity with *RYT 4079, PR 120* and *PR 126* (**Table 1**). Dry matter partitioning indices (DMT and CDMRG) were the highest under weed free throughout treatment which was at par with weed free up to 30 days in case of DMT but also with weed free up to 15 days in case of Contribution of pre-anthesis DM remobilization to grain (CDMRG, Table 1). However dry matter translocation efficiency (DMTE) could not vary significantly with crop-weed competition periods.

All the yield attributes were observed to be the highest under weed free throughout treatment (**Table 2**). It was further evident that all yield attributes were statistically similar under weed free throughout and weed free up to 30 days treatment but yield attributes namely; panicle weight, and 1000-grain weight revealed statistical parity with weed free up to 15 days treatment also. Weedy throughout recorded the least value for all the yield attributes. It was further observed that keeping the crop weed free up to 30 days gave grain and straw yield similar to that of full season weed free treatment (**Table 2**). The better growth and development in weed free throughout treatment can be explained in light of the fact that this treatment recorded better emergence, early vigour (**Figure 1**). No competition for resources by surrogate weed in this treatment resulted in better crop growth along with favorable growth attributes data not presented). Many parameters namely; plant tiller count, number of leaves/plant, CGR, dry matter partitioning indices, panicles/m^2, number of filled and unfilled grains/panicle, panicle fertility, grain and straw yield showed statistical parity between weed free throughout and weed free up to 30 days treatment. The results are in harmony with that of Oudhia and Tripathi (2000), who reported that reducing the competition improves the growth and development of rice and ultimately leading to better yields.

Table 2. Effect of crop-weed competition period and genotype on yield attributes of crop

Treatment	Panicles /m^2	Panicle weight (g)	Panicle fertility (%)	1000-grain weight (g)
Crop-weed competition period				
WT	227.8	2.87	84.9	23.8
WF15	283.7	3.13	87.8	25.1
WF30	335.5	3.28	89.1	25.1
WF-Th	343.4	3.34	89.9	25.2
LSD (p=0.05)	8.9	0.22	0.5	0.3
Genotypes				
RYT 4004 (G_1)	293.0	3.17	91.2	27.2
RYT 4005 (G_2)	286.1	3.14	89.5	26.8
RYT 4079 (G_3)	252.1	3.18	87.7	23.6
RYT 4080 (G_4)	286.8	3.22	89.7	26.8
RYT 4081 (G_5)	242.1	2.82	72.6	24.5
PR 120 (G_6)	365.3	2.79	89.4	24.0
PR 126 (G_7)	326.1	3.14	91.5	22.5
SAVA 134 (G_8)	329.3	3.78	91.9	22.9
LSD (p=0.05)	17.9	NS	NS	NS

Among genotypes, it was found that *PR 120* was superior in terms of panicles/m^2 which was significantly *fb SAVA 134* and *PR 126* (both being statistically similar with each other) (**Table 2**). The highest number of filled grains/panicle coupled with the least number of unfilled grains/panicle (data not presented) in case of *SAVA 134* resulted in the highest panicle weight and panicle fertility. Panicle fertility of *SAVA 134* was statistically similar with that of *RYT 4004* and *PR 126*. It was further observed that *SAVA 134* (rice hybrid) recorded significantly the highest grain yield, whereas *RYT 408*1 recorded the lowest

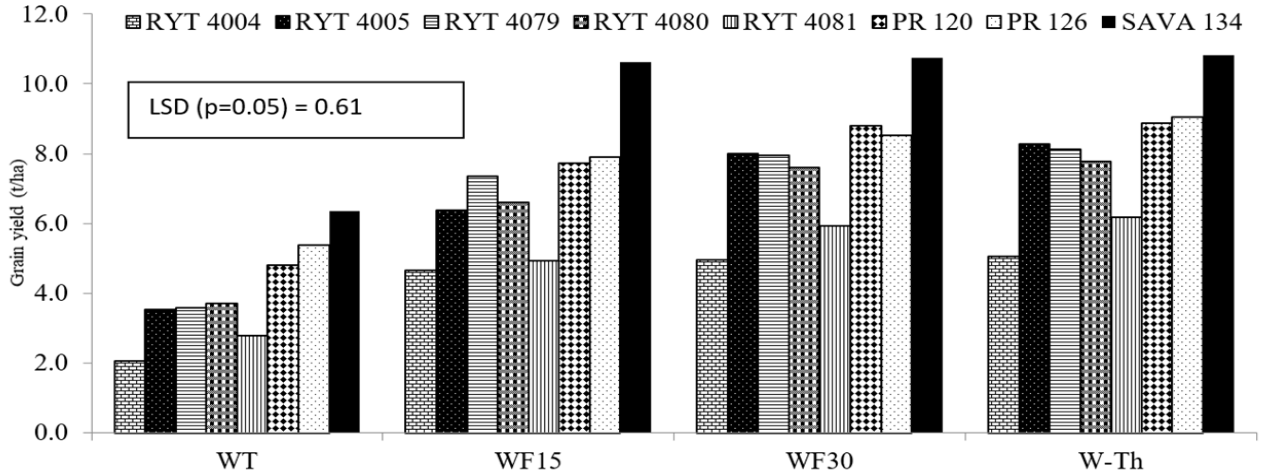

Figure 2. Interaction effects of crop-weed competition period and genotype on grain yield (t/ha) of rice

grain yield (**Table 3**). The range of grain, straw yield and HI among different genotypes was found to be 4.18-9.64 q/ha, 8.27-13.04 q/ha and 3.16-4.52%, respectively. *SAVA 134* was significantly followed by *PR 120* and *PR 126*, which were statistically similar to each other. However, the highest straw yield was recorded in *PR 120*, which was significantly superior over rest of the genotypes. The highest HI was found in PR 126, which was statistically similar *to RYT 4080* and *SAVA 134*.

Among genotypes, variation was observed *w.r.t.* all the parameters; emergence, vigour, yield attributes, yield, weed suppression. These results are in harmony with that of Shrestha *et al.* (2021a and b), who reported variation among rice genotypes for growth and development. Genotypes; *SAVA 134, PR 120* and *PR 126* recorded higher values for all the parameters for crop emergence, vigour, and yield than rest of the genotypes (**Figure 1** and **Table 1-3**). Higher growth and development in former genotypes resulted in better weed suppression by them. Higher grain yield in *SAVA 134* (rice hybrid) can be explained in light of the fact that hybrid rice is considered better yielder, which is in corroboration of our findings (Chauhan *et al.* 2012).

Data on interactive effects of crop weed competition period and genotypes on number of panicles m^{-2} indicate that *SAVA 134* recorded similar number of panicle m^{-2} under different crop weed competition periods i.e., weed free up to 15 days (WF15) and 30 days (WF30) as well as full season weed free treatment (WF-Th) (**Table 4**). However, all other genotypes showed statistical similarity between treatments of weed free up to 30 days (WF30) and weed free throughout (WF-Th) only (**Table 4**)

Table 3. Effect of crop-weed competition period and genotype on grain and straw yield and harvest index (HI) of crop

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	HI (%)
Crop-weed competition period			
Weedy throughout (WT)	4.04	6.38	38.3
Weed free up to 15 days (WF15)	7.02	10.13	40.8
Weed free up to 30 days (WF30)	7.75	11.13	40.9
Weed free throughout (WF-Th)	8.03	11.31	41.3
LSD (p=0.05)	0.34	0.99	1.8
Genotypes			
RYT 4004 (G_1)	6.75	9.19	41.9
RYT 4005 (G_2)	6.30	8.81	41.4
RYT 4079 (G_3)	4.96	8.65	36.6
RYT 4080 (G_4)	6.55	8.27	43.7
RYT 4081 (G_5)	4.18	8.85	31.6
PR 120 (G_6)	7.73	13.04	37.2
PR 126 (G_7)	7.54	9.19	45.2
SAVA 134 (G_8)	9.64	11.91	45.0
LSD (p=0.05)	0.30	0.10	2.4
Crop-weed competition period x Genotypes			
LSD (p=0.05)	0.61	NS	NS

Likewise, data on grain yield brings out that across the genotypes, there were significant differences in grain due to different crop-weed competition periods except WF-Th and WF30, which were statistically similar to each other. But in case of *RYT 4005*, WF15 yielded similar to that of WF30 but keeping the crop WF-Th the season caused significant enhancement in grain yield. Data also brings out that in case of *RYT 4081* and *SAVA 134*, keeping the crop weed free only up to 15 days, yielded similar to that of full season weed free treatment (WF-Th) (**Figure 2**).

Effect on surrogate weed (purple rice): With regards to weed indices, the highest and lowest weed index (WI) values were exhibited by weedy throughout (50.7%) and weed free up to 30 days (3.5%), respectively (**Table 5**). The highest weed control efficiency (WCE) of 100% was recorded in weed free throughout, which was significantly followed by weed free up to 30 days (91.1%). Weed free up to 15 days showed the least WCE (74.1%). However, weed competitive index (WCI) could not vary significantly due to crop-weed competition period.

The lowest WI was recorded *in SAVA 134*, which was significantly *fb PR 120* (**Table 5**). The highest WCE and WCI was recorded in *SAVA 134*, which was statistically similar to *RYT 4004 and RYT 4005, PR 120* and *PR 126* in case of WCE.

The interactive effects also bring out that all the genotypes recorded the highest WI in WT treatment which decreases under WF15 *fb* WF30. However, *RYT 4004*, *RYT 4005, RYT 4081, PR 120* and *SAVA*

Table 4. Interaction effects of crop-weed competition period and genotype on number of panicles/ m^2 of rice

Treatment	WT	WF15	WF30	WF-Th
RYT 4004 (G_1)	211.7	303.3	320.0	337.0
RYT 4005 (G_2)	257.3	273.7	298.3	315.0
RYT 4079 (G_3)	186.7	190.0	308.3	323.3
RYT 4080 (G_4)	185.0	206.7	373.3	382.3
RYT 4081 (G_5)	205.0	235.0	263.3	265.0
PR 120 (G_6)	268.3	380.0	406.0	406.7
PR 126 (G_7)	248.3	335.0	359.3	361.7
SAVA 134 (G_8)	260.0	346.0	355.0	356.0
LSD (p=0.05)		CWCP × G: 17.9		

Table 5. Effect of crop-weed competition period and genotype on weed indices

Treatment	Weed index (%)	Weed control efficiency (%)	Weed competitive index
Crop-weed competition period			
Weedy throughout (WT)	50.7	-	1.09
Weed free up to 15 days (WF15)	12.9	74.1	1.43
Weed free up to 30 days (WF30)	3.5	91.1	1.38
Weed free throughout (WF-Th)	-	100.0	-
LSD (p=0.05)	6.3	4.8	NS
Genotypes			
RYT 4004 (G_1)	22.4	88.7	1.12
RYT 4005 (G_2)	25.6	87.7	0.91
RYT 4079 (G_3)	26.4	85.0	0.55
RYT 4080 (G_4)	27.7	84.5	0.69
RYT 4081 (G_5)	22.8	85.8	0.61
PR 120 (G_6)	19.0	91.7	2.07
PR 126 (G_7)	20.1	91.1	1.39
SAVA 134 (G_8)	14.7	92.6	3.06
LSD (p=0.05)	4.4	5.9	0.50
Crop-weed competition period x Genotypes			
LSD (p=0.05)	7.6	NS	NS

Table 6. Interaction effects of crop-weed competition period and genotype on weed index

Treatment	WT	WF15	WF30
RYT 4004 (G_1)	55.8	9.4	2.1
RYT 4005 (G_2)	52.5	15.3	9.4
RYT 4079 (G_3)	54.8	20.3	4.1
RYT 4080 (G_4)	57.1	22.8	3.2
RYT 4081 (G_5)	58.8	7.7	2.0
PR 120 (G_6)	39.2	12.3	5.6
PR 126 (G_7)	45.9	13.5	0.8
SAVA 134 (G_8)	41.4	1.9	0.7
SEm±		CWCP × G: 3.7	
LSD (p=0.05)		CWCP × G: 7.6	

134 recorded statistically similar weed index for WF15 and WF30. It was further evident that SAVA 134 kept weed free up to 15 days recorded the WI similar to all other genotypes kept weed free up to 30 days (**Table 6**).

Path analysis

The path analysis between crop traits has been presented in **Table 7**. Data reveal that grain yield (-1.5437) exerted very high negative direct effect *fb* LAI at 7 DAS (-0.9185) *fb* plant tillers at physiological maturity (-0.8908) on DMA by surrogate weed at physiological maturity. So, traits like LAI at 7 DAS, plant tillers at physiological maturity, number of leaves at 60 DAS and grain yield exerted direct negative effect on weed DMA at physiological maturity. All the parameters namely; root length (7 DAS), plant height (30 DAS), plant tillers (60, 90 DAS and physiological maturity), flag leaf area, number of leaves plant^{-1} (60 DAS), DMA (30 DAS), dry matter partitioning to panicles (at anthesis), panicles m^{-2} and straw yield exerted high negative indirect effect through grain yield and LAI (7 DAS) on weed DMA at physiological maturity. Similarly, panicles/m^2, plant tillers (60 and 90 DAS) also exerted high negative indirect effect through plant tillers (physiological maturity) on weed DMA at physiological maturity.

Plant competitiveness is thought to be controlled by morphological, physiological, and biochemical traits. Rice genotype with strong weed competitiveness is a low-cost safe strategy for weed management (Singh *et al.* 2016). Rice characteristics related with weed competitiveness include seed size, emergence rate, plant height, early and vigorous growth rate, high tiller number, droopy leaves, high biomass accumulation at early stages, high leaf area index (LAI), rapid ground cover by canopy, high specific leaf area during vegetative growth, deep and prolific roots, resistance to biotic and abiotic stresses and early maturity etc. (Dhillon *et al.* 2021b). Our data also corroborate the above findings (**Figure 1**).

Table 7. Direct and indirect effects of various crop traits on weed dry matter accumulation at physiological maturity (WDMPM)

Treatment	RL 7	LAI 7	PH 30	PT 60	PT 90	PT PM	FLA	LN 60	DMA 30	DMPPA	P/m^2	GY	SY	WDMPM
RL 7	**0.4035**	-0.0668	-0.0973	0.0404	0.0232	-0.0722	-0.0467	-0.2712	0.3770	0.2085	0.0435	-0.9018	0.0254	-0.3346
LAI 7	0.0293	**-0.9185**	-0.0652	0.4167	0.1292	-0.4993	-0.1056	-0.2426	0.5532	0.3535	0.3638	-0.6224	0.0272	-0.5806**
PH 30	0.1819	-0.2776	**-0.2158**	0.3685	0.1146	-0.5876	-0.1531	-0.4523	0.6095	0.3504	0.3741	-1.0355	0.0338	-0.6891**
PT 60	0.0242	-0.5688	-0.1182	**0.673**	0.1846	-0.7733	-0.1536	-0.4673	0.7478	0.3728	0.6265	-1.1852	0.0382	-0.5993**
PT 90	0.0456	-0.5789	-0.1206	0.6057	**0.2051**	-0.7562	-0.1416	-0.4820	0.8020	0.3287	0.5711	-1.1334	0.0380	-0.6164**
PT PM	0.0327	-0.5148	-0.1423	0.5842	0.1741	**-0.8908**	-0.1426	-0.4386	0.6836	0.3028	0.6067	-1.0001	0.0437	-0.7015**
FLA	0.0946	-0.4872	-0.1660	0.5193	0.1459	-0.6381	**-0.1991**	-0.4623	0.6888	0.4706	0.4826	-1.2447	0.0298	-0.7658**
LN 60	0.1887	-0.3843	-0.1683	0.5425	0.1705	-0.6739	-0.1587	**-0.5797**	0.7757	0.3806	0.5191	-1.3519	0.0413	-0.6986**
DMA 30	0.1672	-0.5584	-0.1446	0.5531	0.1808	-0.6693	-0.1507	-0.4943	**0.9098**	0.3766	0.5145	-1.3750	0.0436	-0.6467**
DMPPA	0.1468	-0.5668	-0.1320	0.4379	0.1177	-0.4708	-0.1635	-0.3852	0.5980	**0.5729**	0.384	-1.1226	0.0222	-0.5613**
P/m^2	0.0269	-0.5128	-0.1239	0.6471	0.1797	-0.8294	-0.1474	-0.4619	0.7184	0.3376	**0.6516**	-1.1212	0.0403	-0.5950**
GY	0.2357	-0.3703	-0.1448	0.5167	0.1506	-0.5771	-0.1605	-0.5077	0.8104	0.4166	0.4732	**-1.5437**	0.0405	-0.6604**
SY	0.1823	-0.4451	-0.1299	0.4575	0.1388	-0.6939	-0.1057	-0.4263	0.7070	0.2269	0.4675	-1.1136	**0.0561**	-0.6785**

Conclusion

It can be inferred that keeping the direct-seeded rice crop weed free up to 30 days can result in yield realization similar to that obtained by full season weed free crop. Among tested genotypes, *SAVA 134, PR 120* and *PR 126* were found to be weed suppressive and high yielding genotypes. For attaining an effective weed management strategy, DSR breeding should be focused on traits namely; grain yield, LAI at 7 DAS, root length (7 DAS), flag leaf area, number of leaves / plant (60 DAS), DMA (30 DAS), dry matter partitioning to panicles (at anthesis) and panicle/m^2.

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