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Thermal Response of Scented Rice under Different Weed Management Practices in Organic Production System

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A B S T R A C T

A field experiments on evaluation of weed management practices in scented rice under organic production system was conducted during 2017-18 and 2018-19 at All India Coordinated Research Project on Farming System, Rewa (M.P). The study reveals that weed control efficiency and grain yield of rice were maximum under incorporation of mustard oil cake 5 t/ha+1 HW and two hand weeding at 25 and 50 DAT. The net profit and B:C ratio were maximum under 2 HW at 25 and 50 DAT followed by mulching with locally available weed mulch @ 3 t/ha+1 HW under organic production system which also gave B:C ratio more than 2. Heat use efficiency was maximum 7.94 kg/ha per GDD under incorporation of mustard oil cake @ 5t/ha with one hand weeding followed by 2 HW at 25 and 50 DAT.

Introduction

Rice is a major crop of rice- wheat crop zone of Madhya Pradesh which occupies an area of 19.3 lakh hectares with the production of 27.8 lakh tonnes and average productivity of 1440 kg/ha. Rice crop is sensitive to temperature and weed infestation which greatly influenced the growth, yield and heat use efficiency of rice crop. Organic farming is a production system that avoides the use of synthetic chemical fertilizer, pesticides and growth regulating hormones and raises the crop with the use of organic manures, bio-fertilizers, oilcake, crop rotation, legumes, green manure and biological pest control in rice. Organic farming is not feasible in modern commercial agriculture because it is unable to sustain high level of production to need the food grain supply for the ever increasing population (Tarafdar *et al.*, 2008). Weeds become most limiting factor in organic farming which affect the yield and heat use pattern of rice. None of the cultural practices has been found effective to reduce the weed problem in rice under organic production system and grain yield of rice reduced by 57 to 61% (Mukherjee *et al.*, 2008). Some cultural practices like intercropping of dhaincha in rice, close row spacing or high seed rate, stale seed bed,

mulching by crop residues or tree leaves, hand weeding and hoeing are being found effective to reduce the weed problem under organic rice production system. Any practices aimed at enhancing competitive availability of the crop and weed can bring down the adverse effect of weed on rice. Seedling vigour, early growth rate, tillering ability, stale seed bed, higher fertilizers dose, hoeing and mulching can give competitive advantage to the crop.

Use of mustard oil cake at higher level has been found beneficial as it increases the growth character of rice which has ability to suppress the weed growth (Islam *et al.*, 2007). Intercropping suppress weeds better then sole cropping and thus provides an opportunity to utilize crop themselves as tools for weed management (Rao and Shetty 1976). Cultivation of rice at narrow/close row spacing has been found effective to reduce the weed growth and increase the rice yield as compared to wider spaced rice crop (Bhan 1968).

In past, degree day techniques have been variously applied to correlate the phenological development of rice crop.

However, phenology ambient temperature interaction of rice crop under different weed control practices in organic production system has not been studied. Keeping above facts in view the present experiment was taken.

Materials and Methods

The present experiment was taken on silty clay loam soil of All India coordinated research project on farming system, Kuthulia farm JNKVV, college of agriculture, Rewa during kharif season of 2017-18 and 2018-19. The experimental field was low in available nitrogen (180.31 kg/ha), medium in available phosphorus (16.93 kg/ha) and high in available potash (283.6 kg/ha). The cropping system was rice- garlic. The scented variety of rice PS-5 was transplanted 8 and 9 July in 2017 and 2018, respectively. Two seedlings per hill were transplanted at the planting geometry of 20cm ×15cm in all the plots and in T4 at 15cm×15cm. The plot size was 5m×4.2m. The weed control treatments were T_1-2 Hand wedding 25 and 50 DAT, T_2-conoweeder at 25 DAT+ one hand wedding at 50 DAT, T_3- Intercropping with dhaincha in rice, T_4-stale seed bed+ reduced spacing up to 25 %+ mulching with wheat straw+ one hand wedding, T_5- locally available weed mulch+one hand pulling, T_6- Incorporation of mustard oil cake 15 days before transplanting @ 5t/ha +1 HW and T_7-ITK treatment on weed control practiced by farmers as mulching with leaf of mango under organic production system. The experimental design was RBD with three replication.

Dates were recorded for panicle emergence and maturity of crops. The growing degree days were calculated using 10^0c as base temperature and accumulated over the different growth stages (Iwata 1975, Nuttosson, 1955 and Shastry and Chakravorty 1982). Photothermal units (PTU) were calculated by multiplying growing degree days (GDD) today length. Heat use efficiency (HUE) for different stages was evaluated using above ground biomass and grain yield. The phenothermal index was also calculated by following Nuttonson (1955) and Shastry and Chakravorty (1982).

Results and Discussion

Phenology

Data pertaining to occurrence of phenological events of scented rice crop under the influence of different weed control practices in organic production system is presented in Table 1. It is evident from the result that early panicle emergence and maturity of rice were observed

under two hand weeding at 25 and 50 DAT followed by Incorporation of mustard oil cake @ 5t/ha+ 1HW. Panicle emergence and maturity of rice were delayed under stale seed bed and reduced spacing upto 25% + one hand weeding and in intercropping with dhaincha in 3:1 row system.

Energy summation indices during crop growth period Growing degree days

The data presented in Table 1. In respect to growing degree days (GDD) reveals that higher growing degree days (GDD) were required under stale seed bed+reduced spacing upto 25%+one hand weeding at 50 DAT followed by intercropping of dhaincha with rice in 1:3 row system as weed control practices. GDD requirement (2054 GDD) was lower under two hand weeding at 25 and 50 DAT and incorporation of mustard oil cake @ 5t/ha+1HW. It may be due better weed control efficiency of these treatments in scented rice PS-5.

Photothermal units

The photothermal unit (PTU) for sowing to panicle emergence and sowing to maturity stage under different weed control practices in organic rice production system have been presented in Table 1 reveals that requirements of PTU were higher in the treatments in which weed control efficiency was poor like stale seed bed+reduced spacing upto 25%+1 HW and intercropping of dhaincha with rice in 1:3 row system. The treatments having better growth and weed control efficiency have lower PTU requirements such as two hand weeding at 25 and 50 DAT and incorporation of mustard oil cake @5t/ha+1 HW.

Phenothermal indices

Degree day utilization rates per day between different phenological stages were computed and have been presented in Table 1. It is evident that phenothermal indices were higher during sowing to panicle emergence stage of rice as compared to sowing to maturity stage.

It may be due to continuous decrease in temperature during September and October. The value of phenothermal indices during sowing to panicle emergence and sowing to maturity stage were not affected significantly due to different weed control treatments given in organic rice production.

Heat use efficiency

Heat use efficiency for grain and biomass yield of rice under different weed control practices under organic production system have been presented in Table 2. After perusal of result it is clear that heat use efficiency of biomass was higher than grain yield of rice.

Lowest heat use efficiency 5.7 kg biomass/ha per GDD was noted under intercropping of dhaicha with rice in 1:3 row system. It may be due to replacement of 25% rows of rice by dhaicha by which yield was reduced.

Maximum heat use efficiency 7.94 kg/ha per GDD was noted under incorporation of mustard oil cake 5 t/ha with one hand weeding given at 25 DAT followed two hand weeding given at 25 and 50 DAT. Heat utilization efficiency by rice grain was significantly low 1.68 kg/ha per GDD under farmers practice of mulching of mango leaves for weed control followed by intercropping of dhaincha with rice in 1:3 row system.

The heat use efficiency were higher under two hand weeding at 25 DAT and 50 DAT and incorporation of mustard oil cake 5 t/ha+one hand weeding. It may be due higher weed control efficiency and lower infestation of weeds in rice field under these treatments.

Table.1 Number of days taken, growing degree days, photothermal and phenothermal units of rice as influenced by weed control practices under organic production system

Treatment	Number of days taken		Growing degree days		Photothermal unit at different stages		Phenothermal indices degree days / growth days	
	$S\text{-}P_E$	S-M	$S\text{-}P_E$	S-M	$S\text{-}P_E$	S-M	$S\text{-}P_E$	S-M
T_1 Two hand weeding 25 and 50 DAT	80.3	108.3	1550	2054	14024	18185	19.30	18.96
T_2 Cono weeder 25 DAT + one HW at 50 DAT	82.3	109.3	1585	2071	14320	18321	19.25	18.94
T_3 Inter cropping with Dhaincha	83.0	113.3	1600	2131	14444	18810	19.27	18.80
T_4 Stale seed bed + reduced spacing up to (25%) + mulching with wheat straw + one hand weeding	86.3	114.3	1654	2146	14892	18938	19.16	18.77
T_5 Locally available weed mulch + 1 hand pulling	86.6	109.3	1550	2071	14024	18321	19.23	18.94
T_6 Incorporation of mustard oil cake 15 days before sowing @ 5t/ha +1HW	81.3	109.3	1568	2071	14171	18321	19.28	18.94
T_7 ITK treatment on weed control practices by farmers as mulching with leaf on mango	82.3	109.6	1585	2071	14320	18321	19.25	18.88

$S\text{-}P_E$ = Sowing to panicle emergence
S-M = Sowing to maturity

Table.2 Heat use efficiency of rice as influenced by different weed control practices under organic production system

Treatment	Heat use efficiency by biomass kg/ha/GDD at sowing to maturity			Heat use efficiency by grain kg/GDD/ha Sowing to maturity		
	Year 2017	Year 2018	Mean	Year 2017	Year 2018	Mean
T_1 Two hand weeding 25 and 50 DAT	5.83	8.12	6.97	2.14	2.89	2.51
T_2 Cono weeder 25 DAT + one HW at 50 DAT	7.05	6.56	6.80	1.98	2.33	2.15
T_3 Inter cropping with Dhaincha	6.30	5.19	5.74	1.76	1.82	1.79
T_4 Stale seed bed + reduced spacing up to (25%) + mulching with wheat straw + one hand weeding	5.99	5.80	5.89	1.97	2.06	2.01
T_5 Locally available weed mulch + 1 hand pulling	6.48	6.55	6.51	2.26	2.28	2.27
T_6 Incorporation of mustard oil cake 15 days before sowing @ 5t/ha +1HW	8.74	7.15	7.94	2.64	2.59	2.61
T_7 ITK treatment on weed control practices by farmers as mulching with leaf on mango	6.77	5.02	5.89	1.72	1.64	1.68
$S_E M\pm$	0.32	0.36	0.34	0.05	0.10	0.07
CD at 5%	1.00	1.13	1.04	0.17	0.32	0.21

Table.3 grain and straw yield of riceas influenced by different weed management practices under organic production system

Treatment	Straw yield q/ha			Grain yield q/ha		
	Year 2017	Year 2018	Mean	Year 2017	Year 2018	Mean
T_1 Two hand weeding 25 and 50 DAT	100.98	107.28	104.13	46.87	59.63	53.25 (53.90%)
T_2 Cono weeder 25 DAT + one HW at 50 DAT	104.34	87.40	95.87	41.80	48.52	45.16 (30.52%)
T_3 Inter cropping with Dhaincha	96.76	71.91	84.33	37.70	38.87	38.28 (10.63%)
T_4 Stale seed bed + reduced spacing up to (25%) + mulching with wheat straw + one hand weeding	86.24	80.09	83.16	42.38	44.43	43.40 (25.43%)
T_5 Locally available weed mulch + 1 hand pulling	87.40	88.57	87.98	47.06	47.35	47.20 (36.41%)
T_6 Incorporation of mustard oil cake 15 days before sowing @ 5t/ha +1HW	127.46	94.42	110.94	54.78	53.78	54.28 (56.87%)
T_7 ITK treatment on weed control practices by farmers as mulching with leaf on mango	85.30	73.16	79.23	35.01	34.20	34.60 (0.00%)
$S_EM\pm$	1.69	6.22	3.95	3.02	2.15	2.58
CD at 5%	5.19	19.11	12.15	9.28	6.60	7.94

Figures in parentheses are % increase over T_7- farmers practice

Table.4 Weed control efficiency, Net profit and B:C ratio under different weed control practices in organic production system

Treatment	Weed control efficiency%			Net profit Rs/ha			B:C ratio Rs/Rs		
	Year 2017	Year 2018	Mean	Year 2017	Year 2018	Mean	Year 2017	Year 2018	Mean
T_1 Two hand weeding 25 and 50 DAT	52.26	46.91	49.58	56965	77647	67306	2.16	2.35	2.25
T_2 Cono weeder 25 DAT + one HW at 50 DAT	42.50	31.29	36.84	50669	54419	52544	2.05	1.97	2.01
T_3 Inter cropping with Dhaincha	32.40	40.46	36.43	48769	43096	45932	2.18	1.94	2.06
T_4 Stale seed bed + reduced spacing up to (25%) + mulching with wheat straw + one hand weeding	15.32	25.58	20.45	48321	46909	47615	1.97	1.86	1.91
T_5 Locally available weed mulch + 1 hand pulling	27.52	12.43	19.97	62061	56732	59396	2.38	2.10	2.24
T_6 Incorporation of mustard oil cake 15 days before sowing @ 5t/ha +1HW	67.94	53.50	60.72	-4435	-10457	-7446	1.03	0.92	0.97
T_7 ITK treatment on weed control practices by farmers as mulching with leaf on mango	00.00	00.00	00.00	31262	32990	32126	1.72	1.71	1.71

Grain and straw yield

The grain and straw yield of rice under the influence of different weed management practices in organic production have been given in Table 3 reveals that maximum rice yield 54.28 q/ha was recorded under incorporation of mustard oil cake 5 t/ha+1 HW followed by two hand weeding at 25 and 50 DAT. These treatments gave 53% to 57% higher grain yield than farmers practice of mulching with mango leaves in rice field. It may be due to better weed control efficiency as compared to mulching with mango leaf. Similar trend in straw yield was also reported. Beneficial effect of mustard oil cake @5 t/ha+1 HW on rice was also reported by Islam *et al.*, (2007).

Weed control efficiency

Weed control efficiency 60.72% was maximum under incorporation of oil cake 5 t/ha+1 HW followed by 49.58% in two hand weeding at 25 and 50 DAT (Table 4). Other weed control practices gave 19.97% to 36.84% weed control efficiency as compared to farmers practice of weed control as mulching with mango leaves.

Net profit and B:C ratio

The net profit of rice under different weed control practice in organic production system has been presented in Table 4. It is clear that net profit of Rs 67306/ha was maximum under 2 HW at 25 and 50 DAT followed by Rs 59396/ha under locally available weed mulch+1 HW and hoeing through conoweeder at 25 DAT+ 1 HW at 50 DAT. Incorporation of mustard oil cake 5 t/ha+1 HW was not found economical as compared to farmers practice of mulching with mango leaves. B:C ratio 2.25 was maximum under 2 HW at 25 and 50 DAT followed by 2.24 under locally available weed mulch+1 HW. Other treatments of weed control like intercropping of dhaincha with rice in 1:3 row system and hoeing through conoweeder at 25 DAT+1 HW at 50 DAT gave B:C ratio more than 2. Rest of weed control treatments gave B:C ratio below 2. The positive effect of 2 HW was also reported by Ramamoorthy *et al.*, (2009).

On the basis of above field experiment it is concluded that application of mustard oil cake 5 t/ha+1 HW gave maximum grain yield of rice but was not found economical due to higher cost of oil cake. Two hand weeding at 25 and 50 DAT gave maximum net profit and B:C ratio followed by mulching with locally available weed mulch @ 3 t/ha+1 HW as weed control treatment under organic production system. These treatments gave B:C ratio higher than 2.

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