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Potentiality of mustard oil cake for improving fine rice yield

Z. Sultana, M. P. Anwar, M. M. Islam, N. Yasmin and M. A. R. Sarkar
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract: A randomized complete block designed experiment having three replications was conducted at the Agronomy Field Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during *aman* season (July to December) of 2007 where mustard oil cake was tried at different levels (0, 25, 50, 75 and 100 kg ha^{-1}) and times (basal, 10 days after transplanting and 20 days after transplanting) with a high yielding fine rice variety BRRI dhan38. It was found that level of mustard oil cake and time of its application and their interaction exerted significant influence on all the characters of crop except panicle length and 1000-grain weight. Grain yields registered an increasing trend upto 75 kg ha^{-1} MOC. The highest grain yield (2.33 t ha^{-1}) was recorded from the MOC @ 75kg ha^{-1} applied at 10 DAT. Economic analysis showed that the highest net profit (Tk. 25421.7 ha^{-1}) and the highest benefit cost ratio (1.56) were recorded when MOC was applied @ 75 kg ha^{-1}. Therefore, application of MOC @ 75 kg ha^{-1} at 10 DAT appears to be the best package for BRRI dhan38 from both yield and economic viewpoints.

Key words: Level, application time, mustard oil cake, grain yield and BRRI dhan38

Introduction

Rice can be categorized into coarse, medium and fine based on the size of the grain. Fine rice having small grain, pleasant aroma, and soft texture is the most valued rice (Dutta *et al*., 1998). Fine rice cultivars have some special appeal of their fragrance besides high palatability of grains. This rice is used in many ways by the people but in "Polau" preparation it is the only rice that is mostly used. Besides, the price of 1 kg fine rice is Tk. 70-80 whereas 1 kg coarse milled rice is Tk. 35-40. Because of high price and likeability of this rice, its export can bring considerable amount of forex for the nation. So, cultivation of fine rice is becoming more popular day by day due to its remunerative price and huge export potentiality (Gangaiak and Prashad, 1999). But the yield of fine rice is lower than that of coarse and medium rice. The reasons for low yield are mainly associated with lack of improved varieties, poor fertilizers management and so on. Use of fertilizers is an essential component of modern farming (Pradhan, 1992). Long time intensive use of chemical fertilizers creates some fertility problems through soil exhaustion as well as interaction with other elements (Rahman and Mian, 1997) and causes micronutrients deficiency. In Bangladesh, nutritional deficiency of soil is increasing day by day. The present status of organic matter in Bangladesh is very low and below the critical level (1.5%) (BARC,1997). Bangladesh has a great constraint to maintain soil organic matter under high temperature and high rainfall condition. The organic manure is traditionally is an important source for supplying nutrients for rice in Bangladesh and recognized as a substitute of inorganic fertilizers (Sharma and Mitra, 1991). In past 25 years, use of inorganic fertilizers has been increased rapidly, whereas utilization of organic manures decreased due to various reasons including the unavailability of organic manures. Among the different organic manures available in Bangladesh, mustard oil cake (MOC) is a highly valued one. MOC contains high amount of macro and micro nutrients. Mustard oil cake supplies 5.1-5.2%, 1.8-1.9%, 1.1-1.3% N, P and K, respectively (BARC, 1997). It also supplies sufficient amount of S, Zn and B for the growth and yield of rice. But in Bangladesh, its use is very much limited to some vegetable and ornamental plants only. It has not been used so far in rice by the farmers. But, very recently research work aimed to explore the possibility of application of MOC in rice has just been initiated. The highest grain yield of rice (7.06 t ha^{-1}) was obtained from the application of mustard oil cake @ 75 kg ha^{-1} along with recommended chemical fertilizers (BRRI, 2004). Ali *et al*. (2001) recorded the highest rice grain yield from the combination of 50% N as MOC with 50% N as urea, and they also opined that like plant height, total tillers $hill^{-1}$, LAI, dry matter production and straw yield were influenced by MOC application. But for maximum utilization of applied MOC, what is important that to standardize its level and time of application for a particular variety and growing season as well, otherwise it may not be economically viable. The present study was undertaken to evaluate the potentiality of use of MOC in rice production, and to find out the optimum dose and proper time of application of MOC for obtaining higher yield of BRRI dhan38.

Materials and Methods

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to December 2007 to evaluate the effect of level of mustard oil cake (MOC) and its time of application on the performance of fine rice cv. BRRI dhan38. The experiment included five different levels of MOC viz., 0, 25, 50, 75 and 100 kg ha^{-1} and three different times of application of MOC viz., basal dose, 10 days after transplanting (DAT) and 20 DAT. BRRI dhan38 was used as planting material. The experiment was laid out in a randomized complete block design with three replications. The size of unit plot was 2.5m × 2.0m. Forty-days-old seedlings were transplanted on 23 August 2007 at the rate of 3 seedlings $hill^{-1}$ with 25cm × 15cm spacing. Each plot was fertilized with TSP, MOP, gypsum and zinc sulphate @ 100, 70, 60 and 10 kg ha^{-1}, respectively during the time of final land preparation, and urea @ 150 kg ha^{-1} was top dressed in three equal splits at 15, 30 and 45 DAT. MOC was top dressed to the plots as

per treatment. Necessary intercultural operations were done in order to ensure and maintain the normal growth of the crop. When 90% of grain became golden yellow in color, ten hills (excluding border hills) were randomly selected from each unit plot for recording data on different crop characters like plant height, number of effective tillers hill^{-1}, number of non-effective tillers hill^{-1}, panicle length, number of grains panicle^{-1}, number of sterile spikelets panicle^{-1} and 1000-grain weight, while grain and straw yields were recorded from central 1 m^2 area. Data were analyzed and mean differences were adjudged by Duncan's Multiple Range Test. The cost of individual head of expenditure, gross return, net profit and benefit cost ratio were recorded and partial budget analysis was also done.

Results and Discussion

Effect of level of MOC: Level of mustard oil cake exhibited significant influence in almost all the parameters studied except panicle length and 1000-grain weight (Table 1). Plant height increased linearly with the increasing level of MOC and was recorded the highest (102.54 cm) with the highest level of MOC (100 kg ha^{-1}), and the shortest one (95.71cm) was found in control (no MOC). These results completely concurred with those of Islam *et al.* (2007) who reported that application of MOC increased plant height of rice.

Table 1. Effect of level of MOC on performance of BRRI dhan38

Level of mustard oil cake (kg ha^{-1})	Plant height (cm)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
0	95.71c	8.03d	4.61a	23.70	116.97e	40.25a	21.06	1.91d	2.96c	39.21c
25	99.09b	8.69c	3.57b	24.17	121.00d	35.69b	21.16	2.11c	3.20b	39.73c
50	100.93a	9.53b	3.40b	24.00	125.53c	31.58c	21.22	2.33b	3.24b	41.70a
75	101.25a	12.19a	2.76c	24.58	139.52a	20.58e	21.38	2.61a	3.60a	42.04a
100	102.54a	9.78b	3.45b	24.45	133.91b	24.65d	21.17	2.28b	3.31ab	41.00ab
Level of significance	0.01	0.01	0.01	NS	0.01	0.01	NS	0.01	0.05	0.01
$S_{\bar{x}}$	0.74	0.15	0.12	_	1.26	0.825	_	0.03	0.08	0.55
CV (%)	4.73	8.72	9.69	5.02	6.97	8.07	6.10	6.37	7.49	4.38

Figures in column having similar letter (s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT. NS = Not significant, CV = Coefficient of variation.

The yield contributing characters like number of effective tillers hill^{-1} (12.19) and grains panicle^{-1} (139.52) were found the highest whereas yield retarding characters like number of non-effective tillers hill^{-1} and number of sterile spikelets panicle^{-1} were recorded the lowest (2.76 and 20.58, respectively) with 75 kg MOC ha^{-1}. These results are conformity with those of BRRI (2004) who reported that highest grains panicle^{-1} (132) was found with application of MOC @ 75 kg ha^{-1} over control treatment. On the other hand, number of effective tillers hill^{-1} and number of grains panicle^{-1} were found the lowest (8.03 and 116.97, respectively), and number of sterile spikelets panicle^{-1} was recorded the highest (40.25) when MOC was not applied which resulted in the lowest grain yield (1.91 t ha^{-1}). These results closely resemble to those of Karmakar and Ali (2005a) and Karmakar and Ali (2005b) who also recorded the lowest rice grain yield from the plots receiving no MOC. Grain yield was gradually increased with the increasing level of MOC up to 75 kg ha^{-1}. The highest grain yield (2.61 t ha^{-1}) was obtained from 75 kg MOC ha^{-1} and the lowest one (1.91 t ha^{-1}) was found with control treatment (Table 1). Increase in grain yield due to application of MOC was mainly due to improvement of yield contributing characters i.e. no. of effective tillers hill^{-1} and no. of grains panicle^{-1}. These results were similar to the findings of Islam *et al.* (2007) who observed that rice grain yield was increased with the application of MOC upto 80 kg ha^{-1}. The highest straw yield (3.60 t ha^{-1}) was obtained from 75 kg MOC ha^{-1} and the lowest one (2.96 t ha^{-1}) was recorded in control treatment (Table 1). In case of harvest index an increasing trend upto 75 kg ha^{-1} of MOC was recorded which was statistically similar to 50 kg MOC ha^{-1}.

Effect of time of application of MOC: Time of application of MOC exerted significant influence on most of the parameters 0f BRRI dhan38 except panicle length, weight of 1000-grain and harvest index (Table 2). Plant height was the highest (100.62 cm) when MOC was applied as basal while the shortest plant (99.02 cm) was found when MOC was applied at 20 DAT. Islam *et al.* (2007) also reported that tallest plant (135.8 cm) was found in basal application of MOC and the shortest one (131.55 cm) was recorded when MOC was applied at 30 DAT. The yield contributing characters like number of effective tillers hill^{-1} (9.96) and number of grains panicle^{-1} (131.46) were found the highest, and yield retarding characters like number of non-effective tillers hill^{-1} and number of sterile spikelets panicle^{-1} were found the lowest (3.34 and 28.70, respectively) when MOC was applied at 10 DAT. Islam *et al.* (2007) also opined in the same tune. Number of effective tillers hill^{-1} and number of grains panicle^{-1} were found the lowest (9.38 and 124.90, respectively) and number of sterile spikelets panicle^{-1} was recorded the highest (32.70) when MOC was applied at 20 DAT but non-effective tillers hill^{-1} was found highest (3.74) when MOC was applied as basal. Results show a significant variation among different application times of MOC in respect to grain yield. The highest grain yield (2.33 t ha^{-1}) was obtained when MOC was applied at 10 DAT which was

statistically similar to that obtained from the application of MOC at 20 DAT (2.26 t ha^{-1}) and the lowest one (2.17 t ha^{-1}) was found with basal application of MOC (Table 2). BRRI (2007) reported that highest grain yield (7.67 t ha^{-1}) of rice was obtained from 100 kg MOC ha^{-1} MOC was applied as basal. The highest straw yield (3.34 t ha^{-1}) was obtained when MOC was applied at 10 DAT while the lowest one (3.11 tha^{-1}) was found in basal application of MOC (Table 2).

Table 2. Effect of time of application of MOC on the performance of BRRI dhan38

Time of application of mustard oil cake	Plant height (cm)	Effective tillers $hill^{-1}$ (no.)	Non-effective tillers $hill^{-1}$(no.)	Panicle length (cm)	Grains $panicle^{-1}$ (no.)	Sterile spikelets $panicle^{-1}$ (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Basal	100.62a	9.38b	3.74a	24.06	124.90b	30.25b	21.18	2.17b	3.11b	40.60
10 DAT	100.06ab	9.96a	3.34b	24.40	131.46a	28.70b	21.23	2.33a	3.34a	40.62
20 DAT	99.02b	9.59b	3.59ab	24.29	125.82b	32.70a	21.19	2.26a	3.32a	40.51
Level of significance	0.05	0.01	0.01	NS	0.01	0.01	NS	0.01	0.05	NS
$S_{\bar{x}}$	0.44	0.12	0.09	_	0.97	0.63	_	0.03	0.06	_
CV (%)	4.73	8.72	9.69	5.02	6.97	8.07	6.10	6.37	7.49	4.38

Figures in column having similar letter (s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT. DAT= Days after transplanting, NS = Not significant, CV = Coefficient of variation.

Interaction effect of level and time of application of MOC: The interaction effect of level and time of application of MOC significantly influenced plant height, number of effective tillers hill-1, non-effective tillers hill-1, grains panicle-1, sterile spikelets panicle-1, grain yield, straw yield and harvest index of BRRI dhan38 whereas panicle length and 1000-grain weight were unaffected (Table 3). Plant height was the highest (104.77 cm) when 100 kg MOC ha-1 was applied as basal which was statistically identical to 50 kg MOC ha-1, 75 kg MOC ha-1 applied as basal, and 100 kg MOC ha-1 applied at 10 DAT. The shortest plant (93.98 cm) was found when no MOC was applied. The highest number of effective tillers hill-1 (13.33) was recorded when 75kg MOC ha-1 was applied at 10 DAT while that was only 8.04 (the lowest value) when no MOC was applied. The highest number of non-effective tillers hill-1 (4.62) was found in control plot (no MOC) and the lowest one (2.60) was found in the interaction of 75 kg MOC ha-1 × 10 DAT. The highest number of grains panicle-1 (150.77) was obtained from the interaction between 75 kg MOC ha-1 and 10 DAT and the lowest one (112.12) was recorded when no MOC was applied. The maximum number of sterile spikelets panicle-1 (40.25) was produced when no MOC was applied as basal and at 20 DAT and the minimum value (19.22) was recorded when 75 kg MOC ha-1 was applied at 10 DAT. The maximum grain yield of 2.75 t ha-1 was produced when 75 kg MOC ha-1 was applied at 10 DAT while the minimum one (1.83 t ha-1) was obtained when no MOC was applied. The interaction of 75 kg MOC ha-1 × 10 DAT produced the highest straw yield (3.70 t ha-1) and also the highest harvest index (42.63 %).

Table 3. Combined effect of level and time of application of MOC on the performance of BRRI dhan38

Interaction (Level of MOC × Time of application)	**Plant height (cm)**	**Effective tillers hill-1 (no.)**	**Non-effective tillers hill-1 (no.)**	**Panicle length (cm)**	**Grains panicle-1 (no.)**	**Sterile spikelets panicle-1 (no.)**	**1000-grain weight (g)**	**Grain yield (t ha-1)**	**Straw yield (t ha-1)**	**Harvest index (%)**
L_0×Basal	93.98f	8.03f	4.65a	23.68	112.12h	40.25a	21.06	1.83e	2.46e	42.16a-c
L_0×10DAT	95.28f	8.04f	4.50a	23.70	119.4gh	40.24a	21.07	1.91e	3.21cd	37.30e
L_0×20DAT	97.87e	8.04f	4.46a	23.73	119.4gh	40.25a	21.06	1.93e	3.20cd	37.62e
L_{25}× Basal	98.80de	9.08de	3.90b	23.75	120.1f-h	36.01ab	21.07	1.90e	3.20cd	37.25e
L_{25}×10DAT	99.87c-e	8.60ef	3.53bc	24.18	122.3ef	34.90b	21.23	2.34cd	3.40b-d	40.76c-e
L_{25}×20DAT	98.6e	8.30f	3.40b-d	24.57	120.7f-h	36.17ab	21.23	2.18d	3.10d	41.52a-c
L_{50}× Basal	102.0a-d	9.33de	4.06ab	23.31	124.0e-g	34.94b	21.17	2.27cd	3.16cd	41.60bc
L_{50}× 10DAT	101.2b-e	9.46d	3.00c-e	24.56	127.6d-f	25.64c	21.17	2.41bc	3.33b-d	41.98a-c
L_{50}× 20DAT	99.56c-e	9.80cd	3.40b-d	24.14	125.0e-g	34.18	21.32	2.33cd	3.23cd	42.2abc
L_{75}× Basal	103.5ab	11.73b	2.87de	24.20	133.7b-d	19.69d	21.51	2.52ab	3.60ab	40.99cd
L_{75}× 10DAT	101.4b-e	13.33a	2.60e	24.80	150.77a	19.22d	21.53	2.75a	3.70a	42.63a
L_{75}× 20DAT	98.80de	11.73b	2.83de	24.74	134.1bc	22.82cd	21.11	2.58ab	3.50a-d	42.46ab
L_{100}× Basal	104.77a	8.96de	3.66bc	24.32	134.6bc	20.36cd	21.14	2.33cd	3.18cd	42.00a-c
L_{100}× 10DAT	102.6a-c	10.40c	2.96c-e	24.75	137.24b	23.53cd	21.16	2.23cd	3.1d	41.99a-c
L_{100}× 20DAT	100.3c-e	9.86cd	3.60bc	24.30	129.9c-e	30.07b	21.22	2.29cd	3.65ab	38.7d
Level of significance	0.01	0.01	0.05	NS	0.01	0.01	NS	0.01	0.01	0.01
S_X	0.99	0.26	0.20	-	2.18	1.42	_	0.06	0.14	0.55
CV (%)	4.73	8.72	9.69	5.02	6.97	8.07	6.10	6..37	7.49	4.38

Figures in column having similar letter (s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT. L_0= No MOC, L_{25}= 25 kg ha^{-1} MOC, L_{50}= 50 kg ha^{-1} MOC, L_{75}= 75 kg ha^{-1} MOC, L_{100}= 100 kg ha^{-1} MOC, DAT= Days after transplanting, NS = Not Significant, CV = Co-efficient of variation.

Economic performance of BRRI dhan38 under different MOC levels: Economic performance of BRRI dhan38 under different levels of MOC was evaluated through cost analysis (Table 4). The analysis showed that the highest gross return (Tk 70650 Tk. ha^{-1}) was obtained from the treatment of 75 kg MOC ha^{-1} and the lowest one (Tk 52190 ha^{-1}) was obtained when MOC was not applied. The second highest gross return (Tk 63110 ha^{-1}) was obtained when MOC was applied @ 50 kg ha^{-1}. In case of net profit, the highest value (Tk 25421.7 ha^{-1}) was obtained from the application of 75 kg MOC ha^{-1} and 50 kg MOC ha^{-1} gave the second highest value (Tk. 18210.2 ha^{-1}). On the other hand, the lowest net profit (Tk 8275.7 ha^{-1}) was found when no MOC was applied. The highest benefit cost ratio (BCR) of 1.56 was found when 75 kg MOC ha^{-1} was applied while the lowest BCR of 1.19 was recorded when no MOC was applied. Therefore, from economic view point application of MOC @ 75 kg ha^{-1} appears as the best.

Table 4. Economic performance of BRRI dhan38 under different levels of MOC application

Level of mustard oil cake (kg/ha)	Product & Byproduct	Yield (t/ha)	Price (Tk/kg)	Value (Tk)	Gross return (Tk)	Cost of production (Tk)	Net profit (Tk)	Benefit cost ratio (BCR)
0	Grain	1.91	25	47750	52190	43914.3	8275.7	1.19
	Straw	2.96	1.5	4440				
25	Grain	2.11	25	52750	57550	44571.3	12978.7	1.29
	Straw	3.20	1.5	4800				
50	Grain	2.33	25	58250	63110	44899.8	18210.2	1.40
	Straw	3.24	1.5	4860				
75	Grain	2.61	25	65250	70650	45228.3	25421.7	1.56
	Straw	3.60	1.5	5400				
100	Grain	2.28	25	57000	61965	45556.8	16408.2	1.36
	Straw	3.31	1.5	4965				

It may, therefore, be concluded that mustard oil cake has tremendous influence on the yield of BRRI dhan38. Thus, to obtain higher grain yield as well as higher BCR from BRRI dhan38, 75 kg ha^{-1} of mustard oil cake should be incorporated into the soil during 0-20 days after transplanting of rice along with recommended NPKSZn fertilizers for this specific zone.

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