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EFFECT OF MANAGEMENT AND SEED RATE ON THE PERFORMANCE OF WHEAT VARIETIES WITH VARYING SEED SIZES

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Abstract

An experiment was conducted with three wheat varieties of varying seed sizes at five seed rates in medium and high management at Wheat Research Centre, Dinajpur during 2004-05 Rabi season to determine the appropriate seed rates for the varieties under different management practices. On an average, high management increased grain yield by 18.4%, but the benefit-cost ratio (BCR) was higher in medium management. Higher grain yield was obtained from varieties Shatabdi (medium sized seed) and Prodip (large sized seed) compared to Sufi (small sized seed) in high management, whereas in medium management, all the varieties produced similar grain yield. Considering yield performance and BCR analysis, the seed rates of Sufi and Shatabdi might be 100 and 120 kg/ha, respectively, for both the managements. Seed rates of Prodip might be 120 and 140 kg/ha for medium and high management, respectively.

Key Words: Management, seed rate, seed size, variety.

Introduction

Wheat *(Triticum aestivum* L.) ranks second among the cereal crops grown in Bangladesh. In the early stages of wheat research in Bangladesh, Gaffer and Rahman (1979) used a spacing of *5* cm between seeds planted in rows 20 cm apart, which is impractical to some extent and seems to be costly. Subsequently, Ali (1980) found no significant difference in yield among the seed rates of 80, 90, 110, and 120 kg/ha in variety Sonalika, and recommended a seed rate of 80 kg/ha for rainfed condition. Wheat area under irrigation is increasing and reached 56% in 2002-03 crop season (Ahmed and Meisner, 1996; BBS, 2005). Now about 80% wheat area is sown under irrigated condition (Barma *et al.,* 2006). A common seed rate of 120 kg/ha has been recommended for all the varieties (Razzaque *et al.,* 2000; Islam *et al.,* 2004). However, farmers are using very high seed rate, sometimes even double of the recommendation for controlling weed as extra benefit (Saunders, 1990). But field observation revealed that farmers' yield is lower compared to research field due to higher plant density, shorter spike length and lower number of grains per spike.

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Recently, Wheat Research Centre (WRC) of Bangladesh Agricultural Research Institute (BARI) developed some modern varieties of wheat. Some of these have bolder grain and some have smaller grain size than the previously released varieties. It seems that for the varieties with larger seed size, higher seed rate may be required, whereas seed rate can be reduced for smaller seed size. Integrated nutrient and pest management may increase yield and require the optimum seed rate to be changed. It was found from WRC field that the varieties with bolder seed failed to produce the expected higher yield even with higher seed rate (WRC, 2004), and it has been suggested that high management may be an option to obtain the expected yield from those varieties. Therefore, it is essential to determine the seed rate of newly developed wheat varieties under contrasting management option for the maximum yield. The present experiment was undertaken to determine the appropriate seed rates of different wheat varieties having varying seed sizes under different management practices for higher grain yield.

Materials and Method

The experiment was conducted at the Research Farm of WRC, BARI, Dinajpur (88°4l´ E and 25°38´ N) during Rabi season of 2004-05. The soil was under the AEZ 1 (Old Himalayan Piedmont). The soil was sandy loam with pH *5.6* (Table 1). Soil organic matter and total N were lower than the critical level. Although available P, exchangeable K and available S were higher than the critical level, the amount was very low for wheat.

Table 1. Soil nutrient status with critical level of experimental site of WRC, Dinajpur.

Nutrient/OM/pH	Amount present	Critical level	Method of extraction
Organic matter (%)	1.10	2.00	Wet oxidation
Total N(%)	0.08	0.10	Kjeldahl
Available P (ppm)	12.40	8.00	Modified Olsen
Exchangeable K (meq/100g soil)	0.10	0.08	NH_4OAc
Available S (ppm)	12.60	8.00	Calcium dihydrogen phosphate
pH	5.60	-	-

The experiment was laid out in a split-split-plot design with three replications. Two managements: a) medium management-fertilizer nutrients for moderate yield goal i.e., N-P-K-S-B @ 100-27-35-18-1 kg/ha, and b) high management (integrated)- fertilizer nutrients for high yield goal i.e., N-P-K-S-Zn-B-Cowdung @ 120-33-60-22.5-4-1-10,000 kg/ha with Furadan 5G and Tilt 250 EC were as the main plots. The sub-plots were assigned to three

varieties viz., Sufi, Shatabdi, and Prodip, and five seed rates viz., 80, 100, 120, 140, and 160 kg/ha were assigned to the sub-sub plots. Unit plot size was 3m × 4m. Seed size (according to 1000-grain weight) of these varieties were 35-40, 41-46, and 53-58 g, representing small, medium bold and bold grain, respectively. Two-thirds of N-fertilizer and full amount of other fertilizers were applied as basal and the rest of N-fertilizer was applied at 19 days after sowing (DAS). In high management treatment, well-decomposed cowdung was spread one week before sowing, Furadan 5G was applied @ 30 kg/ha before sowing and Tilt 250 EC was sprayed @ 1 L/ha before anthesis (70 DAS) and at grain filling stage (85 DAS). Seeds were sown on 2 December 2004 at the rate in accordance with the treatments. Prior to sowing, seeds were treated with a systemic fungicide Vitavax-200. Two irrigations were applied at 19 and 61 DAS. Weeds were controlled by spraying 2,4-D amine at 30 DAS.

Plant population and tiller production were recorded at 10 and 39 DAS, respectively. Lodging percentage was recorded at 87 DAS by visual observation. The disease Bipolaris leaf blight (BpLB) was assessed during grain filling stage (90 DAS) for each plot following the double-digit (00-99) scale of Saari and Prescott (1975). The first digit (D_1) indicates the disease progress in height (vertical disease progress), and the second digit (D_2) refers to severity measured as the diseased leaf area. The percentage of disease severity was estimated according to the following formula (Sharma and Duveiller, 2003). % disease severity = $(D_1/9)$ x $(D_2/9)$ × 100.

Number of days required for physiological maturity was recorded. Spike density, plant height and spike length were recorded at physiological maturity. Other yield contributing characters and grain (adjusted to 12% moisture) and biomass (sun-dried) yields were recorded after harvesting. The data were analyzed statistically and means were compared by Duncan's Multiple Range Test (DMRT). Benefit-cost ratio (BCR) was calculated based on market price during the experimentation period.

Results and Discussion

Plant characters, yield and yield attributes as affected by management, variety and seed rate: Management effect was significant on tiller number per unit area, 1000-grain weight, and grain yield (Table 2). Significantly higher number of tillers resulted in remarkably higher number of spikes per unit area in high management. Significantly higher (18.4%) grain yield was obtained from high management with higher 1000-grain weight. Plant population was dependent on the seed size i.e., number of plants per unit area was higher in a variety, which had smaller seed, and obviously it increased with the increase in seed rate (Table 2). Number of tillers per unit area was found higher in Shatabdi and lower in Prodip, and it also increased with the increase in seed rate upto 140 kg/ha. The increasing rate of tillers per unit area was less compared to

Table 2. Grain yield, yield attributes and some other characters of wheat as influenced by management, variety, and seed rate.

Treatments	Plant population	No. of tillers/m^2	Days to physiolo-gical maturity	Plant height (cm)	No. of spikes/ m^2	Spike length (cm)	No. of spikelets/ spike	No. of grains/ spike	100-grain wt (g)	Grain yield (t/ha)	Biomass yield (t/ha)
Management											
M_1	199	417b	100	101	304	11.1	18.8	52.0	47.lb	3.81b	9.24
M_2	206	484a	101	102	321	11.3	19.0	52.4	48.6a	4.51a	10.88
F-test	ns	* *	ns	ns	ns	ns	ns	ns	*	*	ns
CV (%)	18.38	4.14	2.42	2.05	6.75	2.57	4.31	7.33	2.67	18.56	22.34
Variety											
Sufi (35-40)	228 a	456 b	98 b	103 a	338 a	10.8 b	19.6 a	59.9 a	40.1 c	3.93 b	9.99 b
Shatabdi(41-46)	213b	528a	104a	l0lb	318b	l0.4c	17.5b	47.8b	45.9b	4.27a	10.75 a
Prodip (53-58)	167 c	367 c	99 b	99 c	282 c	12.4 a	19.6 a	48.9 b	57.5 a	4.27 a	9.43 c
F-test	**	**	**	**	**	**	**	**	**	**	**
CV (%)	9.90	13.74	1.69	2.29	6.71	4.44	6.15	6.76	4.74	5.48	7.60
Seed rate (kg/ha)											
80	135 e	364 d	101 a	101	267 d	11.4 a	19.3 a	53.6 a	48.4 a	4.03 b	9.73 b
100	174d	435c	l0la	102	303c	11.3ab	19.2ab	52.9a	48.3 a	4.20ab	9.99ab
120	202c	467b	l0la	102	324b	11.2abc	18.8abc	52.lab	47.6b	4.26a	10.35 a
140	236b	494a	100b	101	340a	11.0bc	18.7bc	51.7ab	47.6b	4.27 a	10.20 a
160	267a	491a	l00b	101	330ab	10.9c	18.5c	50.6b	47.4b	4.02b	l0.02ab
F-test	**	**	**	ns	**	**	*	**	**	**	*
CV (%)	6.88	6.78	0.87	1.58	7.05	3.78	4.13	4.76	2.06	6.19	5.48

Figures in the parentheses indicate 1000-grain weight (g) of the variety.
** and ns; significant at 5 and 1% level of probability, and not significant, respectively.
Within a column, for a factor, the figures having same letter(s) do not differ significantly at 5% level of probability by DMRT.
M_1 (medium management): 100-27-35-18-1 kg N-P-K-S-B/ha
M_2 (high management): 120-33-60-22.5-4-1-10,000 kg N-P-K-S-Zn-B-Cowdung/ha with Furadan 5G and Tilt 250 EC @ 30 kg and 2 L/ ha, respectively.

increasing rate of plant population. Number of spikes per unit area was found higher in Sufi and lower in Prodip, and it also increased with the increase in seed rate upto 140 kg/ha and the increasing rate of spikes per unit area was less compared to increasing rate of plant population. This trend indicates that in higher seed rates competition among the plants started before maximum tillering stage, which was manifested in low increase in tiller and spike production. Sarker *et al.* (2007) reported similar trend.

Among the varieties, Shatabdi was found late maturing compared to Sufi and Prodip (Table 2). The variety Sufi was taller than other varieties, but seed rate did not affect the plant height significantly. Prodip produced the longest spike among the varieties. Seed rate more than 120 kg/ha significantly reduced the spike length. Number of spikelets per spike was found higher in Sufi and Prodip compared to Shatabdi and it decreased with the increase in seed rate. Sufi produced significantly higher number of grains per spike than other varieties, but the number of grains per spike decreased gradually with the increase in seed rate. Thousand-grain weight was the highest in Prodip, while the lowest 1000-grain weight was recorded in Sufi. Seed rate more than 100 kg/ha significantly reduced 1000-grain weight. Grain yields were similar in Shatabdi and Prodip but higher than Sufi. Almost similar variations in grain yields, 1000-grain weight, and other yield components were observed among the varieties Shatabdi, Prodip, and Sufi in different trials (WRC, 2005; 2006). The variety Sufi failed to produce higher grain yield due to its smaller grain size despite having higher number of spikes per unit area and grains per spike. Even with lower number of spikes per unit area, variety Prodip produced higher grain yield due to its bolder grain size. Although the highest grain yield was obtained at the seed rate of 140 kg/ha the yield advantage over 120 kg/ha was only 10 kg/ha. In Pakistan, where duration of winter is longer than Bangladesh, higher grain yield was obtained with a seed rate of 100 kg/ha (Khan, 2003). Total biomass yield was highest in Shatabdi and lowest in Prodip. Higher biomass production in Shatabdi compared to different varieties and advanced breeding lines were also recorded (WRC, 2005; 2006). Total biomass production was almost similar with the seed rates from 100 to 160 kg/ha. In higher seed rates, higher number of plants and tillers failed to produce higher biomass yield.

Interaction effect of management and variety: In medium management (without Tilt), disease (BpLB) severity was less in Shatabdi compared to other varieties (Table 3). It indicates that this variety has resistance to BpLB to some extent. Relatively low BpLB severity in Shatabdi compared to other two varieties was also observed in field-testing under artificially inoculated condition (WRC, 2004). Spraying of Tilt reduced the disease significantly in all the varieties. Reduction of disease severity was higher in Prodip and Shatabdi than in Sufi. High management enhanced lodging remarkably in Sufi and slightly in Shatabdi,

but the variety Prodip was completely free from lodging in both the managements. Lower disease reduction in Sufi under high management might be due to remarkably higher percentage of lodging (Table 3), which creates high humidity and warm temperature in the crop canopy favouring disease development and reducing fungicidal efficacy and spray efficiency. Under high management, significantly higher grain yield was obtained from Prodip and Shatabdi than from Sufi. In medium management, all the varieties produced similar but significantly lower grain yields.

Table 3. Interaction effect of management and variety on disease severity, lodging, yield and yield contributing characters of wheat.

Management	Variety	Disease severity (%)	Lodging (%)	Number of tillers/ m^2	Number of spikes/ m^2	Number of grains/ spike[1]	1000-grain wt (g)	Grain yield (t/ha)
M_1	Sufi	26.1 a	6.68	425	327	59.6	39.4	3.73 c
	Shatabcli	20.2 b	0.00	472	310	47.7	45.9	3.87 c
	Prodip	26.7 a	0.00	353	276	48.7	56.1	3.83 C
M_2	Sufi	18.8b	15.73	488	349	60.1	40.8	4.14b
	Shatabdi	10.9 c	1.47	584	326	47.8	45.9	4.68 a
	Prodip	11.8 c	0.00	381	289	49.2	59.0	4.72 a
F-test		*	nS	ns	ns	flS	fls	* *
CV (%)		-	-	13.74	6.71	6.76	4.74	5.48

*, **, and ns; significant at 5 and 1% level of probability, and not significant, respectively. Within a column, the figures having same letter(s) do not differ significantly at 5% level of probability by DMRT.

Percentage data were transformed by square root (for disease severity) and arc sine (for lodging) transformation method before analysis.

M_1 (medium management): 100-27-35-18-1 kg N-P-K-S-B/ha

M_2 (high management): 120-33-60-22.5-4-1-10,000 kg N-P-K-S-Zn-B-Cowdung/ha with Furadan 5G and Tilt 250 EC @ 30 kg and 2 L/ha, respectively.

Interaction effect of management and seed rate: There was an increasing trend in tiller production with the increase in seed rate under high management (Table 4). In medium management, tiller number increased upto the seed rate of 140 kg/ha and then decreased. Therefore, competition among tillers in higher seed rate began earlier in medium management than in high management. Similar trend was observed in spike number per unit area.

Table 4. Interaction effect of management and seed rate on disease severity, lodging, yield and yield contributing characters of wheat.

Management	Seed rate (kg/ha)	Disease severity (%)	Lodging (%)	No. of tillers/ m^2	No. of spikes/ m^2	No. of grains/ spike	100-grain wt (g)	Grain yield (t/ha)
M_1	80	23.6	0.03	349 f	258	53.9	47.8	3.69
	100	23.3	0.00	380e	287	52.4	47.5	3.81
	120	24.6	0.00	437d	319	52.1	46.7	4.08
	140	25.4	6.11	462cd	339	51.4	47.1	3.81
	160	24.7	5.00	455d	319	50.2	46.6	3.64
M_2	80	13.9	0.56	379 e	275	53.4	49.0	4.37
	100	12.5	3.56	490bc	319	53.4	49.1	4.58
	120	13.4	4.11	497b	329	52.6	48.6	4.61
	140	14.3	5.78	526a	342	51.6	48.1	4.61
	160	15.0	14.67	528 a	342	50.9	48.1	4.39
F-test		ns	ns	**	ns	ns	ns	ns
CV(%)		-	-	6.78	7.05	4.76	2.06	6.19

** and ns; significant at 1% level of probability and not significant, respectively.

Within a column, the figures having same letter(s) do not differ significantly at 5% level of probability by DMRT.

Percentage data were transformed by square root (for disease severity) and arc sine (for lodging) transformation method before analysis.

M_1 (medium management): 100-27-35-18-1 kg N-P-K-S-B/ha

M_2 (high management): 120-33-60-22.5-4-1-10,000 kg N-P-K-S-Zn-B-Cowdung/ha with Furadan 5G and Tilt 250 EC @ 30 kg and 2 L/ha, respectively.

Interaction effect of variety and seed rate: Lodging was higher in variety Sufi and it increased with the increase in seed rate (Table 5). Very little tendency of lodging was found in variety Shatabdi, while lodging was not at all observed in Prodip. Tolerance to lodging in Prodip was also observed in different field experiments conducted by WRC (WRC, 2005; 2006). Strong and stout stem, relatively short phenotype and erect plant type might have contributed to lodging tolerance in this variety. Significantly higher number of tillers per unit area was found in Shatabdi at higher seed rates. Prodip produced significantly lower number of tillers. In all the three varieties, number of tillers increased with the increase in seed rate except in Shatabdi at 160 kg/ha. It indicated that competition among tillers in the variety Shatabdi started earlier at higher seed rate because of its high tillering ability.

Table 5. Interaction effect of variety and seed rate on disease severity, lodging, yield and yield contributing characters of wheat.

Variety	Seed rate (kg/ha)	Disease severity (%)	Lodging (%)	No. of tillers/ m^2	No. of spikes/ m^2	No. of grains/ spike	100-grain wt (g)	Grain yield (t/ha)
Sufi	80	22.0	0.88cd	357fgh	273	61.8	40.7	3.91
	100	21.2	2.83cd	440cd	325	60.7	40.3	4.07
	120	22.0	6.17c	*456c*	349	58.0	40.2	4.06
	140	23.9	17.00b	507b	373	*61.5*	39.9	3.94
	160	23.0	29.17a	522b	371	57.4	39.4	3.71
Shatabdi	80	15.0	0.00 d	409 de	*275*	48.6	46.3	*4.05*
	100	14.6	2.50cd	516b	307	49.0	*46.5*	4.31
	120	15.2	0.00 d	560 a	331	47.8	45.3	*4.56*
	140	16.9	0.83 cd	593 a	346	46.3	45.9	4.25
	160	15.8	0.33cd	562a	330	47.2	45.6	4.21
Prodip	80	19.1	0.00d	326h	251	50.6	58.3	4.14
	100	17.9	0.00d	350gh	277	49.1	58.1	4.24
	120	19.8	0.00 d	384 efg	292	49.7	57.3	4.48
	140	18.7	0.00 d	383 efg	302	48.2	56.9	4.36
	160	ns	**	**	ns	ns	ns	ns
F-test		-	-	6.78	7.05	4.76	2.06	6.19
CV(%)								

** and ns; significant at 1% level of probability and not significant, respectively.

Within a colunm, the figures having same letter(s) do not differ significantly at 5% level of probability by DMRT.

Percentage data were transformed by square root (for disease severity) and arc sine (for lodging) transformation method before analysis.

Interaction effect of management, variety and seed rate: In both the managements, higher severity of BpLB was observed in Sufi and Prodip than in Shatabdi (Table 6). Therefore, Shatabdi has some resistance to BpLB disease under field condition. A little higher disease severity was observed in higher seed rate, especially under medium management in Sufi and Shatabdi. Increase in disease severity at higher seed rate has also been reported by others (Singh *et al.*, 1998), which might be due to higher plant density creating favourable microclimate for rapid development and spread of the disease. However, spraying of Tilt reduced the disease severity in all the varieties and higher reduction was obtained in Prodip.

6. Interaction effect of management, variety and seed rate on disease severity.

Seed rate (kg/ha)	M_1			M_2		
	Sufi	Shatabdi	Prodip	Sufi	Shatabdi	Prodip
	Disease severity					
80	24.7 abc	18.9 de	27.2 ab	19.3 de	11.1 gh	11.1 gh
100	24.7 abc	19.3 de	25.9 ab	17.7 ef	9.9 h	9.9 h
120	24.7abc	19.3de	29.6a	19.3de	11.lgh	9.9h
140	30.0a	22.6bcd	23.5bcd	17.7ef	11.lgh	14.0fg
160	26.3ab	20.6cde	27.2ab	19.8de	11.lgh	14.0fg
F-test	*					

*; significant at 5% level of probability.

Figures having same letter(s) do not differ significantly at 5% level of probability by DMRT.

Data were transformed by square root transformation method before analysis.

M_1 (medium management): 100-27-35-18-1 kg N-P-K-S-B/ha

M_2 (high management): 120-33-60-22.5-4-1-10,000 kg N-P-K-S-Zn-B-Cowdung/ ha with Furadan 5G and Tilt 250 EC @ 30 kg and 2 L/ha, respectively.

Although the interaction effect of managements, varieties, and seed rates was not significant on grain yield, apparently the highest yield was obtained from variety Prodip with 140 kg/ha seed rate under high management (Table 7). Shatabdi and Sufi produced higher yield with 120 and 100 kg/ha seed rate, respectively. In medium management, all the varieties produced higher yields with 120 kg/ha seed rate. The yield advantage of Sufi at 120 kg/ha seed rate over 100 kg/ha was only 20 kg/ha. The benefit-cost ratio (BCR) in medium management was higher than in high management (Table 7). In each management and variety, where the grain yield was higher, the BCR was also higher except in Sufi in medium management. The variety Sufi gave higher BCR with 100 kg seed/ha. Therefore, seed rates of Sufi and Shatabdi might be 100 and 120 kg/ha, respectively, for both the managements, and that of Prodip might be 120 and 140 kg/ha for medium and high management, respectively.

Since the initial plant population was similar in both the managements, it appeared that the effect of Furadan was insignificant (Table 2). This might be due to low insect population of the soil. Therefore, if Shatabdi were grown in high management without Furadan and Tilt, the BCR would have been high. Seed rate higher than 140 kg/ha in medium management caused lower tiller and spike production per unit area, but the yields were higher at 120 kg/ha in both the

managements across all varieties (Table 4). Seed rate higher than 120 kg/ha failed to produce higher yield due to lower number of grains per spike and lower 1000-grain weight (Table 2). Variety Prodip was more responsive to Tilt spray. In high management, Sufi produced lower yield than Shatabdi and Prodip, whereas similar yields were obtained from these varieties in medium management (Table 3). In both the managements, Sufi produced optimum yield with higher BCR at 100 kg/ha seed rate, and the medium bold seeded Shatabdi produced higher yield with higher BCR at 120 kg ha^{-1} seed rate (Table 7). The bolder seeded variety Prodip produced higher yields with higher BCR at 120 and 140 kg/ha seed rates under medium and high management, respectively. This variety had higher severity of BpLB, higher disease reduction by applying Tilt, and complete resistance against lodging.

7. Interaction effect of management, variety and seed rate on grain yield (t/ha) and benefit-cost ratio (BCR) of wheat.

Seed rate (kg/ha)	M_1						M_2					
	Sufi		Shatabdi		Prodip		Sufi		Shatabdi		Prodip	
	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR
80	3.64	3.21	3.60	3.20	3.83	3.33	4.17	2.17	4.49	2.34	4.45	2.27
100	3.82	3.29	3.84	3.34	3.76	3.20	4.31	2.22	4.78	2.46	4.71	2.36
120	3.84	3.26	4.24	3.61	4.17	3.48	4.27	2.17	4.87	2.47	4.79	2.37
140	3.74	3.15	3.91	3.27	3.79	3.12	4.14	2.09	4.60	2.31	4.92	2.42
160	3.59	2.97	3.77	3.10	3.57	2.91	3.82	1.94	4.65	2.31	4.71	2.28

M_1 (medium management): 100-27-35-18-1 kg N-P-K-S-B/ha

M_2 (high management): 120-33-60-22.5-4-1-10,000 kg N-P-K-S-Zn-B-Cowdung/ha with Furadan

5G and Tilt 250 EC @ 30 kg and 2 L/ha

Price of inputs:

N = Tk. 13.04 kg^{-1}, P = Tk. 80.00 kg^{-1}, K = Tk. 28.00 kg^{-1}, S = Tk. 22.22 kg^{-1}, Zn = Tk. 239.00 kg^{-1}, B = Tk. 686.00 kg^{-1}, Cowdung = Tk. 0.30 kg^{-1}, Furadan 5G = Tk. 85.00 kg^{-1}, Tilt 250 EC = Tk. 560.00 $(400m1)^{-1}$, 2, 4-D Amine = Tk. 190.00 $(400m1)^{-1}$, Seed = Tk. 16.00 kg^{-1}, Ploughing (2) = Tk. 1,000.00 h^{-1}, Irrigation (2) = Tk. 1,000.00 ha^{-1}, Spray of Tilt 250 EC (2) = Tk. 360.00 ha^{-1} and Spray of 2, 4-D Amine (1) = Tk. 180.00 h^{-1}, Labour (100) for fertilizer application, sowing, harvesting, threshing etc. = Tk. 6,000.00 h&'.

Price of products:

Grain = TIc. 12.50 kg1 and Straw = Tk. 1.00 kg^{-1}.

Conclusion

High management increased grain yield in all the varieties of wheat, but the response was higher in Shatabdi and Prodip than that of Sufi. The benefit-cost ratio was higher in medium management. The seed rates of Sufi and Shatabdi might be 100 and 120 kg/ha, respectively, for both the managements. Seed rates of Prodip might be 120 and 140 kg/ha for medium and high management, respectively.

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