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Selection of Short Duration Wheat Varieties for Matching Rice–Wheat– Maize Cropping Pattern in Non-Traditional Wheat Areas in Bangladesh

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Abstract:- Eight well adapted wheat varieties received from Regional Wheat Research Centre of Bangladesh Agricultural Research Institute, Gazipur were evaluated in November-March'2018 at CARITAS beneficiary's field located Lama and Alikadam upazilla of Bandarban district, Bangladesh. The varieties were raised following complete randomized block design with four replications. Morpho-agronomic traits were analyzed using cropstat-5 software. This research aimed to identify the potential wheat varieties for corresponding in a Rice-Wheat-Maize cropping pattern ensuring better crop production for food security. At Alikadam, among eight varieties BARI GOM-32 observed as best considering good yield despite of its short height (58.50 cm). However, significant difference did not observe in the same parameter between the varieties except plant height. At Lama, significant variations were found in almost all of the parameters except Grain/spike and plot yield. The highest grain/spike (40) and plot yield (12.38 kg) observed in BARI GOM 31 and BARI GOM-24 but significant variations did not among the varieties. Different morpho-agronomic parameters of the mentioned eight wheat varieties at Alikadam and Lama were compared.

Keywords:- *Wheat, Short-Duration, Non-Traditional Area, Genotypic Performance, Adaptability.*

I. INTRODUCTION

Wheat is the second most important cereal crop of Bangladesh. In 1996, The national average yield of wheat is 1.90 metric t/ha, which is considered lower as compared to many wheat growing countries of the world (Ahmed and Meisner, 1996). However, in 2019 in turns into 3.20 metric t/ha which is excellent and higher compare to many wheat growing country including Australia (Faruq et al., 2019)

Wheat is not an indigenous crop of Alikadam and Lama Upazilla of Bandarban district as well as of Bangladesh. In Bangladesh it was introduced 50 years ago despite of a so-called land races named Khari (Khari was introduced by Portuguese 300 hundred years ago) and wheat is growing in Rabi season (Mid November to March). In November, 2018 eight varieties were grown at Lama and Alikadam Upazilla of Bandarban District. The varieties collected from Regional Wheat Research Centre, of Bangladesh Agricultural Research Institute, Gazipur. All of these varieties are well adapted in wheat growing zone of Bangladesh. However, it was the first time that these varieties were use in a wheat varietal screening process at Bandarban Hill Districts.

II. OBJECTIVES

The main objectives of this experiment were:

1. To identify the potential wheat varieties with good yield, these can match in Rice-Wheat-Maize cropping pattern at Lama and Alikadam.
2. To ensure wheat sustainability at Bandarban hill district.

III. METHODOLOGY

➢ *Plant Materials*

Eight wheat varieties named:

1. BARI GOM-25
2. BARI GOM-27
3. BARI GOM-28
4. BARI GOM-29
5. BARI GOM-30
6. BARI GOM-31
7. BARI GOM-32
8. BARI GOM-33

Were collected from Regional Wheat Research Centre, Joydebpur, Gazipur

➢ *Methods*

Planting date : 15 November' 2018
Locations **:** Alikadam and Lama Upazilla, Bandarban District, Bangladesh
Plot size : 5 m × 5 m = 25 square meter
Row-to-Row distance : 20 cm
Plant-to-Plant distance : 5 cm
Crop management : Fertilizer-

UREA -21 gm, TSP 15 gm, MP 10 gm, GYPSUM 11 gm, ZN- 0.4 gm, BORIC ACID 0.7 gm (two third of urea and all fertilizers applied during final land preparation and the rest one third applied at three leaf stage immediate after irrigation. Weeding was done when it was necessary before booting stage. Three irrigations were applied at 18 days 40 days and 60 days after sowing.

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Number of Replication : 4
Design : Randomized Block Design

Recorded data :
i. Days to Heading (Days)
ii. Days to Maturity (Days)
iii. Days to Grain Filling (Days)
iv. Number of Tillers (Nos)
v. Plant Height (cm)
vi. Grain per Spike (Nos)
vii. Thousand Grain Weight (gm)
viii. Yield per Plot (Kg)

Statistical analysis : Data were analyzed using cropstat-5 software.

IV. OBSERBED RESULTS

➢ *Alikadam Observations*

The mean performance of different yield contributing characters in some variety of wheat is displayed in Table 1. The observed results indicating that, days to heading (DH); days to maturity (DM) and days to grain filling (DGF) are earlier in BARI GOM-33 (52.25), BARI GOM-32 (92.75) and BARI GOM-28 (38.5) accordingly. For other parameters such as number of tillers (NT), grain/spike (G/S), thousand grains weight (TGW) and yield/plot (Y/P), the variety BARI GOM-30 (4.3), BARI GOM 24 (for G/S - 39.25 and TGW-58g) and BARI GOM-33 (2.53 kg) performed superior compare to other varieties. In addition, though BARI GOM-24 noticed as the tallest (73.25cm) genotypes but the variety BARI GOM-32 was superior considering good yield despite of its short height (58.50 cm). Amusingly, it is also mentionable that all the parameters were non-significant except plant height in these studies.

➢ *Lama Observations*

The performance of different yield contributing characters as average of some wheat varieties are shown in Table 2. From this Table, it is concluded that significant variation were found in almost all the parameters like days to heading (DH), days to maturity (DM), days to grain filling (DGF), number of tillers (NT), plant height (PH) and thousand grain weight (TGW). Days to heading and days to grain filling observed earlier in BARI GOM-24 (43.50) and BARI GOM-31 (40.00) respectively. Lowest days to maturity observed same (93.50) in BARI GOM 25 and BARI GOM-28. BARI GOM-33 performed highest number of tillers (12.50)

Variety	DH	DM	DGF	NT	PHT (cm)	G/S	TGW (gm)	Y/P (kg)
BARI GOM-24	54	94	40	3.5	**73.25 a**	**39.25**	**58**	1.91
BARI GOM-25	58.75	93	43.25	3.8	64.50bc	30.75	55.5	1.67
BARI GOM-28	55.25	93.5	**38.5**	4	59.25c	32.75	54.5	1.68
BARI GOM-29	56.5	95	38.75	4	72.25a	38	54.25	2.07
BARI GOM-30	53.75	94.5	40.75	**4.3**	67.00ab	33.5	50.75	2.06
BARI GOM-31	53.75	93.25	39.5	4	71.50ab	28.25	50	1.9
BARI GOM-32	52.75	**92.75**	40	4	**58.50**c	29.75	54.5	2.2
BARI GOM-33	**52.25**	93	40.75	3.5	72.50a	36.75	52.25	**2.53**
CV%	**13.47**	**1.89**	**16.21**	**20.5**	**7.58**	**28.40**	**9.57**	**38.16**
Probability	**ns**	**ns**	**ns**	**ns**	*	**ns**	**ns**	**ns**
LSD value(0.05)	-	-	-	-	**7.51**	-	-	-

Table 1:- Mean performance of different yield contributing characters of wheat

***=Significant at 5% level, **= Significant at 1% level, ***= Significant at 0.1% level and ns=Non Significant**

And thousand-grain weight (53.50g). Shorter plant height were observed in BARI GOM-30 (64.50cm) followed by BARI GOM-28 (71cm) and BARI GOM-25 (72.50cm). The highest number of grain/spike (40) and plot yield (12.38 kg) detected in the variety BARI GOM 31 and BARI GOM-24 without any significant variations with other varieties.

VARIETY	DH	DM	DGF	NT	PHT (cm)	G/S	TGW (gm)	Y/P (kg)
BARI GOM-24	**43.50f**	95.50 ab	50.50 a	11.50 a	77.50ab	35	49.50 d	**12.38**
BARI GOM-25	46.50 e	**93.50 c**	45.50 b	9.500 b	72.50cd	32	51.00 bcd	11.5
BARI GOM-28	49.50 c	**93.50 c**	45.50 b	8.500 bc	71.00 d	25.5	50.50 cd	11.26
BARI GOM-29	47.50de	94.50 bc	44.50 b	9.500 b	80.50 a	28	50.50 cd	11.06
BARI GOM-30	53.50 b	96.50 a	44.50 b	8.500 bc	**64.50 e**	29.5	51.50 bc	10.02
BARI GOM-31	**57.50 a**	96.50 a	**40.00 d**	8.000 c	77.50ab	**40**	51.50 bc	10.5
BARI GOM-32	48.50cd	96.50 a	49.50 a	9.500 b	76.00bc	29	52.50 ab	8.75
BARI GOM-33	54.00 b	96.50 a	42.50 c	**12.50 a**	78.50ab	31	**53.50 a**	12.25
CV%	**1.56**	**0.79**	**1.69**	**6.09**	**2.15**	**20.84**	**1.26**	**10.39**
Probability	***	*	***	**	***	**ns**	**	**ns**
LSD value(0.05)	**1.99**	**1.79**	**1.66**	**1.39**	**3.79**	-	**1.53**	-

Table 2:- Mean performance of different yield contributing characters of wheat

***=Significant at 5% level, **= Significant at 1% level, ***= Significant at 0.1% level and ns=Non Significant**

➢ *Comparison of Different Morpho-Agronomic Parameters of Wheat Varieties at Alikadam and Lama*

The climatic condition of Lama and Alikadam upazilla of Bandarban district are supposed to be same since the distance is only around 10 Kilometers between the upazillas. Despite of that, remarkable variations were observed in all parameters among the eight wheat varieties. It may happen due to the difference of the topography of these two locations as well as the differences of crop management practices. In fact, the farmers were not familiar with growing wheat. Training was provided before planting begun, however, some of the farmers struggled to follow the proper protocols which was reflected in their data collection on different agronomic parameters, and finally significant yield variation were observed among the varieties in these two locations. In addition, Alikadam site was more open and located beside the road whereas Lama site is situated on the hill slope with comparatively cooler environment which also may have caused the variations observed

➢ *Comparison of days to heading and days to maturity at Alikadam and Lama*

When we consider the days to heading, significant difference is observed among the

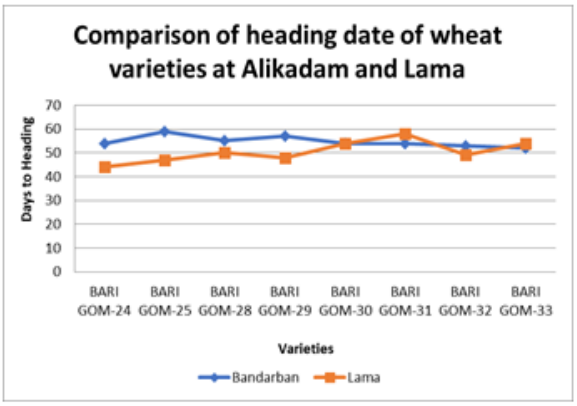

Fig 1

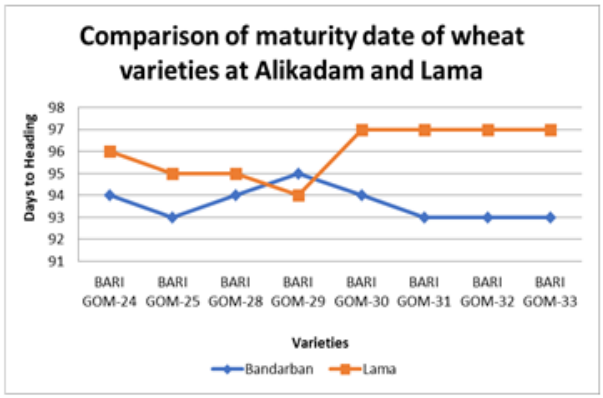

Fig 2

Varieties at Lama but the difference was not significant at Alikadam (Fig1 and Fig 2). Higher heading days observed in BARI GOM-24, BARI GOM-25, BARI GOM-28 BARI GOM-29 and BARI GOM-32 at Alikadam. On the contrary, higher days to heading observed in BARI GOM-30 BARI GOM-31 and BARI GOM-33 at Lama. When we considered days to maturity significant difference was observed among the varieties at Lama but the difference was not significant at Alikadam (Table 1 and Table 2). A higher day to maturity was observed in all varieties except BARI GOM-29 at Lama.

➢ *Comparison of days to grain filling and number of tillers at Alikadam and Lama*

When we considered days to grain filling, significant difference was observed among the varieties at Lama but the difference was not significant at Alikadam (Fig 3, Fig 4). Higher grain filling days was observed in all varieties at Lama compare to Alikadam.

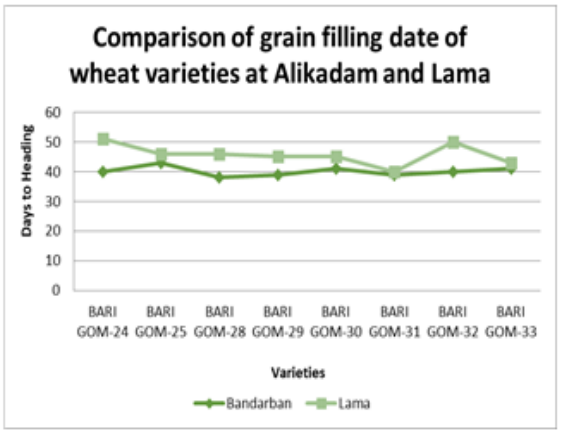

Fig 3

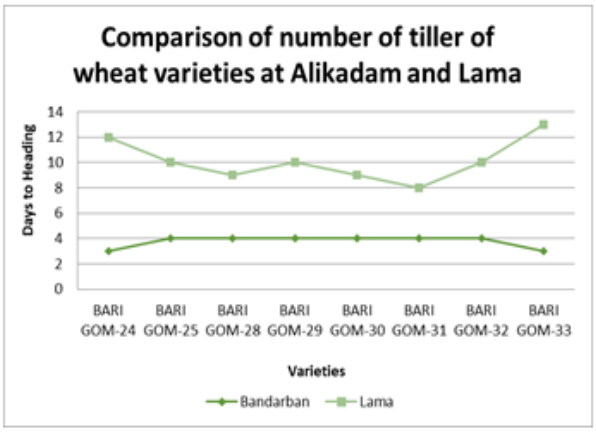

Fig 4

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When we considered number of tiller, significant difference observed was among the varieties at Lama but the difference was not significant at Alikadam (Fig 3 Fig 4). Higher number of tillers observed in all varieties at Lama. Severely stressed plants reached maturity earlier than non-stressed plants (Ihsan et al. 2016). It is expected that severely stressed plants have higher rate of grain filling. This higher rate and shorter grain filling period resulted in improper translocation of photosynthates that caused a yield decline. Ihsan et al (2016) had reported that genotype Faisalabad-2008 had 38% longer grain filling period over sensitive wheat genotypes under severe drought stress. So, grain filling duration is a genetically controlled trait and can be used for drought resistant genotypes selection.

➢ *Comparison of plant height and grain per spike at Alikadam and Lama*

Significant difference was observed in plant height among the varieties in both locations. However, significant different was not observed in grain per spike in two locations (Fig 5 Fig 6). Higher grain per spike was observed in all varieties except BARI GOM-25 and BARI GOM-31 at Lama. Overall plant height was low at the both locations. Reduction in plant height in wheat due to drought stress was also reported by Khakwani et al. (2012) and Nouri-Ganbalani et al., (2009). Khannachopra et al., (1994) reported that reduction in number of grains spike^{-1} in wheat under water stress but the extent of reduction was different in various genotypes.

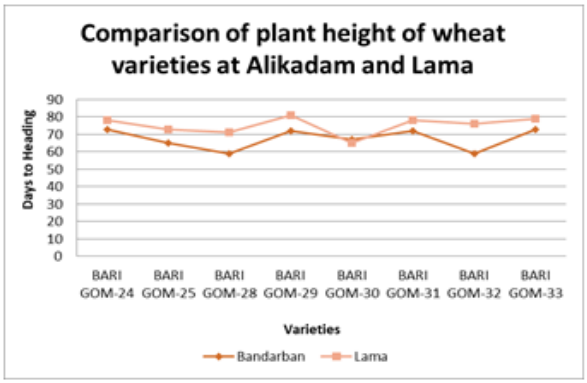

Fig 5

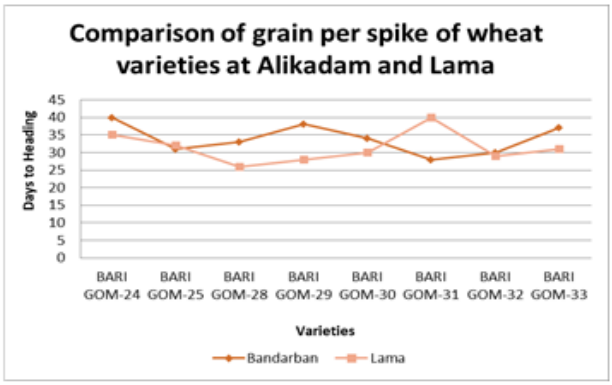

Fig 6

➢ *Comparison of thousand grain weight and yield per plot at Alikadam and Lama*

Significant difference did not occur in thousand-grain weight and yield per plot among the varieties in both locations. However, significantly higher variation in plot yield was recorded at Lama compared to Alikadam in all varieties. In grain per spike, significant difference was not observed at the two locations (Fig 7 Fig 8). When thousand-grain weight considered, most of the varieties performed higher at Alikadam except BARI GOM-30, BARI GOM-31 and BARI GOM-33 compared to Lama. During grain filling period, heat stress can accelerate leaf senescence and affect final grain weight by shortening the grain filling duration (Dias and Lidon, 2009). Due to climate change, winter is observing shorter in Bangladesh and terminal heat stress is the major problem for obtaining good yield in wheat. The effect of increasing temperature during reproductive phase is more harmful than that of the vegetative phase (Jena *et al.*, 2017). It reduces kernel growth leading to losses in kernel density and weight by up to 7% in spring wheat. Ovary abortion and pollen sterility occurs, which results smaller and inferior grains. Shriveled small grains are produced and different yield associated traits such as tiller habit, grain size, grain weight and grains numbers/spike are reduced. Biological yield, harvest index and spike length are severally decreased which vary genotype to genotype. Many physiological and biochemical processes are negatively affected due to high temperature (Hamam and Khaled, 2009).

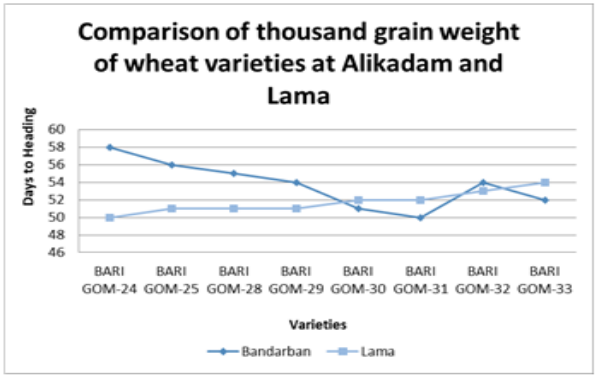

Fig 7

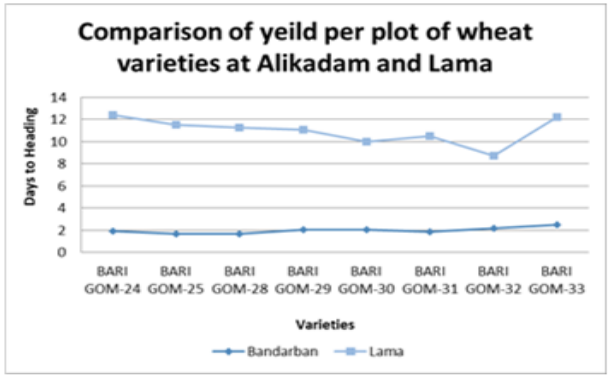

Fig 8

Khan et al., (2005) who observed that 1000-grain weight in wheat was reduced mainly due to increasing water stress.

V. LIMITATIONS AND MODIFICATIONS

Wheat Research Centre of Bangladesh Agricultural Research Institute recommends growing wheat in between 15 to 30 November. In 2018, wheat was planted on 15th November and it was observed that the life cycle became shorter in the hill tracks compared to plant district. This happened due to winter started a little late at the experimental sites. To overcome this limitation, it is planned to shift the sowing date to 30 November in 2019. In addition, farmers were not familiar with wheat cultivation. Therefore, despite of proper instruction they did not manage to follow actual crop management practices. To overcome these limitations, a proper training will be provided before planting and harvesting wheat in 2019 Rabi season.

VI. CONCLUSION

Among three experiments, the first was executed from 15 November' 2018 to 30 March 2019. Using a random sampling method, a sample size of 8 farmers was selected from Lama and Alikadam upazilla of Bandarban hill district, Bangladesh. This initial attempt had a few issues which have been already identified and expect to overcome these issues in the upcoming growing seasons. Each experimental cycle consists of 3 experiments; the first cycle is being carried out in 2018-19 cropping season. The second cycle is expected to be carried out in 2019-20 cropping season. It is expected that after completion of the two cycles, potential wheat, maize and rice varieties will be identified for the proposed rice-wheat-maize cropping pattern. All of the wheat varieties used in this study have good history of tolerance against several biotic and abiotic stresses such as heat, drought, rust, blast and different fungus. Wheat will become one of the major components for a sound agro-ecology and climate resilient crop in hill districts. This experiment conducted at CARITAS beneficiary's plot which could be considered as demonstrations plots and the surrounding farmers will be encouraged to adapt wheat cultivation. Wheat cultivation by using climate resilient varieties could have great impact on the food and nutrition security, socio-economic development of the people of Alikadam and Lama Upazilla of Bandarban district.

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