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Development of an early maturing yellow seeded mung bean variety from local germplasms

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Abstract

As a part of mung bean variety development programme, several local green seeded mung bean varieties were brought to BARDC (BRAC Agricultural Research & Development Centre) during the year 2000. These germplasms were evaluated accordingly, and 2 yellow seed bearing plants were isolated through selection and found to be distinctly different from the green seeded genetic stocks collected from Meherpur. One of them had larger golden yellow coloured grains and was given the name as *YS-I* while the other was *YS-II* having small sized yellow grains. Comprehensive screening and further evaluation of these two yellow seeded strains, *YS-I* was found to be a relatively determinate and short duration line while *YS-II* was identified as an indeterminate type line having longer crop duration. After several years of generation advancement through constant selfing *YS-I* was established as a promising early maturing yellow seeded short duration line. Following rigorous and continuous selection it was improved further and through multilocation adaptive trial this line was also found to be very promising. Field demonstration trials of *YS-I* also brought positive feedback since it matures earlier than other commercial varieties and it has a very good attractive golden colored seed besides its tolerance to cercospora leaf spot and MYMV (Mung bean Yellow Mosaic Virus) disease. Along with better eating quality proximate analysis revealed the fact that *YS-I* is a variety having low fat content compared to green seeded variety BARImung-5 & BINAmung-7.

Keywords: Minerals, nutritional quality, proximate analysis, selection, short duration variety, *Vigna radiata*, yellow seeded mung bean.

INTRODUCTION

Mung bean (*Vigna radiata* L. Wilczek) seeds is an excellent source of high quality vegetable protein in the diets of Asian countries (AVRDC, 2012) and a major source of raw material for the food processing industries to make different kinds of value added food products in these countries including Bangladesh. Along with other pulse crops mung bean is being grown in this South East Asian part of Asia traditionally from the very ancient time as a scented pulse crop for its delicious taste, good flavor, easy cultivation, tolerance to salinity and its typical fitting in the various cropping system (Mogotsi, 2006). Due to its good nutritional quality, soil amelioration properties and also for its recent huge consumption by the local confectioneries for making value added high quality nutritious confectionary products viz, *Dal Bhaja*, *Papad (both are different types of snacks)* etc. mung bean has become a very important agricultural commodity in Bangladesh in recent times. Furthermore, farmers are now getting better price from their produce than before, and mung bean cultivation is generating more income opportunities at the field level during the harvesting period and in the '*Papad'* making villages- as a huge no. of poor women are being employed to collect the fruits of mung bean from the field

and in the preparations of '*Papad'* particularly for the underprivileged section of women in Bangladesh. Again compared to other pulse crops which are usually grown in Bangladesh in the winter season (viz. lentil, chick pea, field pea, grass pea etc.) mung bean is grown in the summer just after harvesting of winter crops and it enjoys few competitor pulse crops at that time and following harvesting of mung bean fruits, the traditional practice is to mix the crop residue with the soil which makes the soil more fertile through the decomposition of the crop residues by seasonal rain water and ensures the supply of green manure into the soil. In the past Bangladeshi farmers used to cultivate a longer duration yellow coloured small seeded traditional variety *'Sonamoog'* but due to its asynchronous flowering, high degree of susceptibility to virus disease, extremely longer crop duration and poor yield farmers no more cultivate this variety. Nevertheless its appealing golden yellow seed coat colour, finer grain quality and good flavour as well as taste is commendable and an improved mung bean variety similar to *'Sonamoog'* has a very good demand among the mung bean growers and consumers as well. Considering above facts a mung bean variety development program was started at BARDC during the year 2000 with an objective to develop good quality early maturing short duration high yielding yellow seeded mung bean variety having moderate seed size and better taste.

MATERIALS AND METHOD

Collection of germplasm: In the year 2000, eight local varieties of mung bean were collected from various sources and different accession numbers were given accordingly. All these accessions (BMU 001, BMU 002, BMU 003, BMU 004, BMU 005, BMU 006, BMU 007 and BMU 008) were almost characteristically different from each other.

Classification of seed colour group: Almost all the accessions had more or less green seed coat colour although seed size variations were noticed. The accession BMU 004 collected from Meherpur had also green seed coat colour but critical observation revealed the fact that it was actually a mixture of three different seed coat colour groups and their Hundred seed weight of these three groups were recorded. The groups were:

i. Green seed coat colour (small seeded group)
ii. Greenish brown seed coat colour (medium size seeded group)
iii. Brown seed coat colour (bold seeded group)

Growing of germplasm: For the evaluation of germplasm each of these accessions along with these three groups were grown in the experimental field of BRAC Agricultural Research and Development Center during the Kharif- 2 season of the year 2000. All the accessions grew well in this season and flowered normally but special attention was paid to the above mentioned three groups. Good fruit setting was noticed in each of the accessions. At the end of the season, seeds were collected separately from each accession and preserved accordingly.

Identification of yellow seeded plants: After threshing of the mature fruits harvested from each group of the Meherpur stock (BMU 004) while the seeds were subjected to drying on the sunny floor, few golden yellow coloured seeds were found among the greenish brown seed coat colour fruit (Medium size) and also from brown seed coat colour group (Bold seeded). Attracted by the golden yellow colour seeds an effort was made to identify the particular plants producing golden yellow seed from mung bean plots and finally two plants were identified by thorough searching of the plants of Greenish brown seed coat colour and Brown seed coat colour group, one from each group, respectively. The bold seeded golden yellow coloured seed type obtained from the medium size seed group was termed as *yellow seed coat-1* or *YS-I* and the smaller size golden yellow coloured seed type obtained from Deep brown seed coat coloured group was given the name *yellow seed coat-II* or *YS-II*.

Growing of pure lines from selected plants: The harvested seeds of *yellow seed coat-I* and *yellow seed coat-II* along with the check variety BARImoog-5 were sown in separate 34 cm. diameter earthen pots during the Kharif-1 season of 2001. For growing each of the pure lines, fresh seeds from each lines were sown in triplicate in three separate earthen pots. Recommended cultural practices were followed to ensure proper growth of the plants of each line. After seedling emergence all the plants grew well and produced normal fruits and seeds like their parents.

Seed increase of the pure lines: Seeds were harvested accordingly from the isolated pure lines and multiplication of the pure lines was also completed in the same Kharif season-1 of 2001 by sowing the fresh harvested seeds of each of the lines in the pot condition. Therefore, after 2 phase of growing of the isolated pure lines 33 g. of seeds were obtained from the line *YS-I* while 20 g. of seeds were obtained from the *YS-II*.

Performance trials of pure line: The trial experiments were conducted at BRAC Agricultural Research and Development Centre (BARDC), Gazipur and its regional

farms located at Dinajpur and Meherpur districts respectively. Newly developed yellow seeded mung bean line *YS-I* along with BARI and BINA released mung bean varieties were used as seed materials while field trials were conducted in 3.00 X 2.55 m plots with three replications laid out in randomized complete block design. Seeds were sown in lines maintaining a distance 30.00 cm between the rows and keeping plant to plant distance 4.00 cm. Normal cultural practices were carried out uniformly to ensure better growth and development of the plants in each trial.

For evaluation of the performance of *YS-I*, observational yield trial and preliminary yield trial were conducted in the experimental plots of BARDC while regional yield trials were carried out in the BRAC seed farms located at Dinajpur and Meherpur districts. In all the trial experiments both BARImung-5 & BINAmung-7 were used as check varieties. For on farm trial a progressive mung bean grower was selected from Natore district as Natore is one of the well known mung bean growing district.

Characters noted from each trials: Observations on plant height, no. of branches and total no. of pods per plant, days taken to 1st flowering, days taken to 1st picking, pod length per pod, no. of seeds per pod, 1000-seed wt., seed yield per plant, crop duration, seed coat colour and yield per hectare were collected at different phases of plant growth and development and were analyzed statistically.

Nutritional quality analysis: Proximate analysis of mung bean seeds was also done from the seeds obtained from the advance line of *YS-I* and different check varieties as well following the standard procedures given in Association of Official Analytical Chemistry (AOAC, 1965).

RESULTS

Evaluation of germplasm & Identification of variants

As variations are the raw materials for improvement of new varieties therefore, an effort was made to identify the variabilities already existed in the collected germplasms and since the accession BMU 004 had variations in the seed size and colour, the total seed stock was categorized into in 3 groups on the basis of 100-seed wt. and colour respectively (Table 1).

Table 1. Different groups of mung bean of accession BMU 004 and their 100-seed wt.

Category	Seed groups	100-seed wt. (g)	Seed colour	Remarks
BRC 001	Green seed coat colour	4.75	Green	Smaller seeds
BRC 002	Greenish brown seed coat colour	5.55	Greenish brown	Medium size
BRC 003	Deep brown seed coat colour	5.65	Deep brown	Bold seeded

Although 100-seed wt. of BRC- 002 & BRC- 003 was very close to each other (5.55 & 5.65 g) BRC- 001 had strikingly lower seed wt. (4.75 g). It is also interesting to note that although these 3 groups belong to the same stock they exhibited difference in different morpho-physiological characteristics (Table 2.). *Greenish brown seeded* group flowered 9 days ahead of *Green seed coat* colour group and 7 days earlier than *Deep brown seed coat* colour group.

Table 2. Morpho-physiological characters of 3 groups of plants separated from the local germplasm collected from Meherpur.

Name of the groups	Plant height (cm)	No. of branches/plant	1st flowering date	Total no. of pods/plant	Pod length/ pod (cm)	No. of seeds/ pod	Crop maturity
Green seed coat colour	35.45±3.10	1.40±0.56	41.00±0.63	16.43±3.48	9.53±0.50	12.00±0.42	56.00
Greenish brown seed coat colour	34.16±3.72	1.24±0.79	32.00±0.54	19.87±4.57	9.79±0.45	11.37±0.49	47.00
Deep brown seed coat colour	34.05±4.23	1.54±0.87	39.00±0.68	22.58±4.89	9.23±0.87	11.14±0.57	55.00
Mean	34.55±3.68	1.39±0.74	37.33±0.62	19.63±4.31	9.52±0.61	11.50±0.49	52.66

After the recovery of yellow seeded variants *YS-I* & *YS-II*, their morphological characters were studied subsequently and differences were also noticed between these 2 variants in almost all the characters studied (Table 3, Fig. 1). Although *Yellow seed coat–II* had increased no. of pod clusters, seed yield/plant was lower due to its smaller size of seeds.

Table 3. Data on plant characters recorded after 1st recovery of yellow seed coat variants.

Characters	*Yellow seed coat-I*	*Yellow seed coat-II*
Plant height (cm)	25.00	27.00
No. of leaves/plant	7.00	7.00
No. branches/plant	-	2.00
No. of pod clusters/plant	4.00	6.00
Total no. of pods/plant	10.00	10.00
Pod length (cm)	6.71±1.92	5.50±1.10
No. of seeds/ pod	9.71±2.50	7.42±3.36
Seed coat colour	Bright golden yellow	Light golden yellow
Seed size	Bold	Small
Seed length (mm)	5.20±0.36	4.00±0.42
Total no. of seeds/plant	90.00	52.00
Seed yield/plant (g)	3.42	2.95
Days to maturity	48.00	54.00
Total no. of plants of the plot	237.00	212.00
No. of yellow seeded plants	1.00	1.00

Pure line selection

To obtain the pure lines of yellow seeded variants the harvested seeds of these variants were multiplied under pot condition and after 2 phases of multiplication the variants were found to be produced plants true to type to their parents and a few no. of off type plants were observed during this multiplication phase. As BARImoog-5 was also grown with these variants clear cut differences between the yellow seeded variants with the normal green seeded mung bean were noticed and *YS-I* was identified as early matured and short duration variant than BARImung-5 while *YS-II* was identified as a late matured variant with smaller size seeds. In the next generation growing under field condition however few plants similar to *YS-II* (5.00%) and totally green coat coloured seed bearing plants (3.00%) were obtained from the *YS-I* stock as off type plants and a considerable no. of *YS-I* type plants (40%) were noticed in the *YS-II* genetic stock in this generation. Off type plants from both the genetic stocks were rogued out categorically to obtain the pure stocks. Harvesting was started on 14.11.01 and near about 2.30 kg of seeds of *yellow seed coat-I* was harvested while 600 g of seeds of *yellow seed coat-II* was harvested at the end of the season (final harvesting date: 23.11.01). Data on yield and yield related traits have been presented in Table 4. In this particular experiment *YS-I* was found to be an early matured strain and its first flowering occurred only at 30 days (3 days earlier than BARImoog-5) while *YS-II* was recorded as late matured strain. Practically plants of the *YS-I* line were characterized by almost determinate type plant and its picking of fruits could be started at 48 days while its harvesting could be completed by 57-58 days. Table 4. also shows that *YS-I* exhibited higher values in most of the other yield parameters than BARImung-5 excepting plant height and 100-seed wt. In fact, *YS-I* had moderate size yellow coloured seed which were slightly smaller than BARImung-5.

Table 4. Comparative study of yield parameters of *Yellow seed coat-I, II* and BARImung-5.

Name of the line	Days taken to flowering	Plant height (cm)	Days taken to 1st picking	No. of branches/plant	No. of pod clusters/plant	Total no. of pods/plant	Pod length/fruit (cm)	Pod wt./plant (g)	No. of seeds/ pod	100-seed wt. (g)	Seed yield/ plant (g)	Harvest Index (%)	Yield increase over *BARI-mung-5 (%)*
YS-I	30.00	25.90 ± 2.98 (21.00-32.00)	48.00	1.60 ± 0.54 (1.00-2.00)	10.50 ± 2.26 (8.00-15.00)	36.73 ± 13.58 (16.00-66.00)	8.07 ± 0.49 (7.50-8.80)	13.69 ± 3.63 (6.50-20.50)	11.66 ± 0.68 (10.40-12.80)	4.46 ± 0.40 (4.16-5.16)	10.44 ± 2.73 (4.61-16.96)	47.44 ± 5.75 (30.00-56.00)	32.99
YS-II	37.00	30.57 ± 4.18 (26.00-37.00)	52.00	2.97 ± 0.67 (2.00-4.00)	15.47 ± 2.97 (9.00-25.00)	48.17 ± 9.78 (33.00-72.00)	9.03 ± 0.45 (8.07-9.87)	21.26 ± 4.07 (13.09-30.32)	11.89 ± 0.57 (10.80-12.70)	3.08 ± 0.18 (2.75-3.40)	14.59 ± 3.14 (8.78-19.85)	33.00 ± 5.59 (21.00-44.00)	85.85
BARI-mung-5	33.00	27.08 ± 4.18 (21.00-34.00)	58.00	1.46 ± 0.57 (1.00-3.00)	7.93 ± 2.63 (4.00-13.00)	21.03± 6.98 (11.00-41.00)	9.58 ± 0.50 (8.94-10.47)	10.28 ± 2.86 (6.61-16.43)	10.83 ± 1.48 (8.50-12.30)	5.80 ± 0.28 (5.21-6.13)	7.85 ± 2.31 (4.10 -12.63)	39.70 ± 9.06 (17.00-58.00)	-

X ± S.D = Mean ± Standard Deviation and values in the parentheses ( ) = range

Observational yield trial (OYT)

In this trial the newly developed yellow seeded strains were tested for observational yield trial. Although the yellow seeded strain performed well during this *Kharif-1* season, few no. of plants were found to be affected in both the strains by MYMV. These virus affected plants were eradicated through roguing and no other off- type plants were noticed other than the virus affected plants from each of the strains in this generation. One of the important feature of *YS-I* was that it had a very good uniformity rate which contributed immensely to its growth, development and finally yield.

Characteristics of the Yellow Seed coat-I line (Figs. 2 & 3; Table 5)

1. Uncommon, dwarf type short duration improved line (crop duration 57 – 58 days) having light green coloured plants.
2. Almost synchronized ripening of fruits.
3. Uncommon attractive golden yellow coloured showy moderate size seed.
4. Tolerant to major diseases (MMV & CLS).
5. Insensitive to seasonal influence and can be grown almost throughout the year.
6. Good cooking quality and less turmeric is required for making cooked products {*dhal*, *khichuri* (cooked form of mixture of fine rice and pulse), *halim* (dhal with small pieces of meat) etc.} and its preparations are very tasteful.
7. Higher seed recovery percentage and the testa of the seeds is very thin.

Table 5. Mean values of plant characters of *Yellow seed coat-I (YS-I)* & BARImung-5 grown in the Kharif season-1 of 2002.

Plant Characters	*YS-I*	BARImung-5
Plant height (cm)	18.00 ± 4.78	22.60 ± 5.80
No. of leaves/plant	14.90 ± 0.82	14.20 ± 0.94
Petiole length (cm)	9.18 ± 1.34 (6.5 - 10.08)	9.93 ± 1.24 (9.00 - 12.20)
Leaflet length (cm)	7.40 ± 0.84 (6.00 - 9.00)	9.93 ± 1.13 (7.50 -12.30)
Leaflet width (cm)	6.24 ± 0.79 (4.80 -7.50)	7.73 ±1.08 (4.30 -10.00)
Leaflet L/W ratio	1.17 ± 0.17 (1.00 - 1.30)	1.25 ± 0.13 (1.10 - 1.50)
Distance of nodes bearing pod clusters (cm)	2.53 ± 1.20 (1.00 - 4.00)	4.05 ± 2.24 (1.00 - 6.20)
Days taken to 1st flowering	31.00 ± 0.50	34.00 ± 0.72
Days taken to 1st picking	47.00 ± 1.48	57.00 ± 1.87
Duration of the crop	58.00 ± 2.31	65.00 ± 3.36
Seed yield/plant (g)	8.01 ± 2.17 (3.98 - 11.80)	7.55 ±3.52 (3.57 - 14.26)

Preliminary yield trial (PYT)

Although the newly developed both yellow seed coat lines were found to be promising after observational yield trial in terms of yield and seed coat colour, since the *YS-II* was found to be susceptible to cercospora leaf spot disease and it was a late matured variety; *YS-II* was kept as a new germplasm to be used for breeding purpose while *YS-I* was subjected to further trials leading to release it as a variety. As a part of PYT, seeds of both *YS-I* and BARImung-5 were sown in field plots and were evaluated at Gazipur farm during late Kharif-1 season. The performance of *YS-I* was found to be more promising as seeds from selected plants of *YS-I* were used for the trial and this promising line was then advanced for further trial experiments.

Adaptability testing and regional yield trial (RYT)

For the evaluation of *YS-I* in different agro ecological zones this new line was grown in Dinajpur BRAC Seed Farm during the Kharif season-2 of 2002 and the results are presented in Table. 6. Since the soil texture of Dinajpur farm was very light *YS-I* did not perform well in this location but the strain was found to be true breeding. This particular line was also once again found to be virus tolerant as well. Pure seeds were collected from selected healthy plants and near about 2.50 kg of good quality seeds were preserved for evaluation in the next season. Subsequently regional yield trial has been completed in this region using check varieties BARImung-5 & BINAmung-7. Similar experiments have also been conducted in the Meherpur farm for adaptability testing as well as regional yield trial. In both the locations *YS-1* exhibited its early matured characteristics with slightly higher yield than the check varieties.

On farm trial

In the following year as a part of MLT during the *Kharif season-1* of 2003 seed samples of *YS-I* were sent to Meherpur for the evaluation of its performance in the western zone famous for mung bean cultivation. Side by side seed samples were also sent to Natore district (another mung bean growing district) for its evaluation under farm condition during the same season. In the Natore district this improved line was grown in 33 decimal of land and this particular field was kept under strict observation to produce good quality seed. Very fine growth and development of *YS-I* was noticed in this sandy loam soil due to good weather condition and no off type plants were observed in this generation. Only a few plants (1%) were found to be affected by MYMV and these plants were eradicated from the field through roguing. An excellent crop was harvested at the end of

the season due to good soil and weather conditions. Following the harvest a part of the total quantity of harvested seed was tested for its local market demand and a good market response was obtained due to its attractive colour and finer quality. It will be worth mentioning here that all other mung bean varieties of the market were traditional green seed coat type having moderate quality. The farmers of Meherpur were also found to be satisfied with this new mung bean line as they harvested a very good crop from it.

Table 6. Adaptability testing of the improved line *YS-I* (in Dinajpur district).

Characteristics	Mean Values
Plant height (cm)	42.00 ± 3.68
Days taken to 1st flowering	29.00 ± 0.38
No. of pods/cluster	4.00 ± 3.10
Total no. of pods/ plant	30.00 ± 11.78
No. of seeds/pod	12.00 ± 0.59
Seed yield/plant (g)	9.80 ± 2.48
Yield/ha (Kg)	429.78 ± 8.87

Generation advancement for further improvement

In subsequent years this promising line *YS-I* was evaluated in both the on farm & on station conditions for the assessment of its yield stability over the years and seasons as well. This generation advancement process was continued up to 2006. Subsequently in the Kharif-1 season of 2007 again a portion of the seed lot produced in Natore district brought to Gazipur and seeds were sown at BARDC experimental field on 15.03.07. Improved quality of YS-I was noticed in this season like the parental type and again seeds of the larger fruits from selected healthy plants were harvested separately and these seeds were carefully preserved for further multiplication and for the advancement of generation.

During the *Kharif-1* season of 2008 these preserved seeds were grown in both early and late *Kharif* season and it has been observed that this mung bean line can be grown more or less throughout the year and even a good crop was harvested after sowing seeds in as early as last week of February and in case of late sown crop *YS-I* can be harvested by sowing seeds in 1st week of October. Interestingly in case of late monsoon crop, after harvesting mung bean other rabi season vegetable & spice crops like tomato, brinjal, onion, hot pepper etc. can be grown in the same field and cropping intensity can be increased.

Table 7. Studies on yield related characters of *YS-I* and 2 check varieties of mung bean grown in the Kharif season-2 of 2011.

Name of the line/ variety	Days taken to 1st flowering	Plant height/ Plant (cm)	No. of branches/ plant	No. of pod clusters/plant	No. of pods/ cluster	Total no. of pods/ plant	Pod length/ Pod (cm)	1000-seed wt. (g)	Yield/ ha (kg)	Virus incidence (%)	Seed recovery (%)	Days to maturity	Crop duration	Yield increase over check
YS-I	28.00	41.18±4.23 (32.00-45.00)	1.50±0.82 (1.00-3.00)	4.40±0.70 (4.00-6.00)	5.40±1.73 (4.00- 9.00)	21.90±7.31 (14.00-38.00)	7.60±0.39 (7.40-8.90)	38.50±0.04 (38.10-38.90)	1045.00	5.43	65.22	45.00	62.00	51.23%-increased than BARI-mung-5 & 92.09%
BARI-mung-5	30.00	47.91±6.46 (35.00-58.00)	1.10±0.32 (1.00-2.00)	5.0±1.07 (4.00-7.00)	5.20± 1.93 (3.00-10.00)	21.0± 7.83 (13.00-39.00)	8.50±2.34 (7.80-10.10)	59.20±0.21 (57.00-61.30)	691.00	6.06	38.42	53.00	70.00	increased than BINA-mung-7.
BINA -mung-7	33.00	50.25±6.0 (39.00-58.00)	3.60±1.84 (0-6.00)	7.70±3.13 (4.00-14.00)	7.10±2.77 (3.00-13.00)	28.90± 4.55 (16.00-58.00)	6.30±0.75 (5.70-8.40)	38.60±0.21 (36.70-40.90)	544.00	17.70	52.31	59.00	74.00	-

Evaluation of newly developed mung bean variety (YS-I) in more advance generation (S_{20})

To compare the performance of *YS-I* in the more advanced generation, it was grown in the experimental field of BARDC in the Kharif season-2 very recently (in 2011) and its performance was evaluated with 2 popular mung bean varieties BARImung-5 & BINAmung-7 data of which has been presented in the Table 7. *YS-I* again proved its earliness in terms of crop maturity than the other 2 varieties due to light green coloured leaves and pods and the crop could be harvested at only 62 DAS while BINAmung-7 was identified as a late matured variety. Its production was also found to be higher (1045 kg/ha) compared to BARImung-5 and BINAmung-7. *YS-I* was found to be less affected by MYMV and seed recovery percentage of *YS-1* was also found to be higher compared to the other 2 varieties.

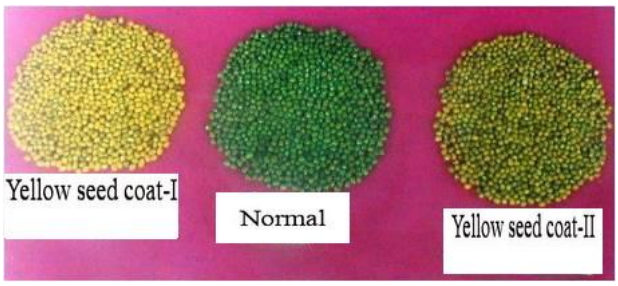
Nutritional quality

The nutritional qualities of the three mung bean varieties (*YS-I*, BARImung-5 and BINAmung-7) was assessed through proximate analysis and the composition of minerals in their seeds are presented in Table 8. Proximate analysis revealed the fact that with respect to crude protein content *YS-I* hold second position and its percentage was 26.50. Relatively higher protein content was recorded in BARImung-5 (27.42%) while BINAmung-7 had the lowest amount of protein (25.19%). It is fascinating to note that the seeds of *YS-I* had the lowest amount of fat than BINAmung-7 and BARImung-5. Near about 4.39% ash was recorded in *YS-I* and maximum ash content was in BINAmung-7 (4.55%). High amount of fibre was observed in BINAmung-7 (6.01%) and minimum fibre was noticed in *YS-I* (5.78%). It can be mentioned here that among the 3 varieties *YS-I* had the highest level of calcium (575 mg/100 g) and relatively lower amount of calcium was recorded in BARImung-5 (525 mg/100 g). β-carotene test in *YS-I* and BARImung-5 revealed the fact that BARImung-5 had the higher amount of β-carotene than *YS-I* (in *YS-I*, β-carotene was 3.32 mg but in BARImung-5 β-carotene content was 3.88 mg per 100 g).

Table 8. Proximate composition of mung bean seeds of *YS-I* and 2 check varieties.

Advance line/variety	*CP (%)	Fat (%)	Ash (%)	Fibre (%)	Moisture (%)	Ca (%)	P (%)
YS-I	26.50 ±1.630	0.615 ± 0.007	4.39 ± 0.280	5.78 ± 0.440	7.44 ± 0.110	0.575 ± 0.007	0.965 ± 0.021
BARImung-5	27.42 ± 0.300	0.835 ± 0.021	4.20 ± 0.035	5.98 ± 0.590	9.59 ± 0.070	0.525 ± 0.020	0.985 ± 0.007
BINAmung-7	25.19 ± 0.060	0.800 ± 0.040	4.55 ± 0.014	6.01 ± 1.400	8.96 ± 0.200	0.560 ± 0.014	0.970 ± 0.021

$\bar{X}$ ± S.D = Mean ± Standard Deviation *CP = Crude Protein



DISCUSSION

In the local mung bean germplasms lack of sufficient genetic variability is the major constraint for its improvement. And cultivars of mung bean now in cultivation in Bangladesh so far have been developed principally by selection from local strains, introduction, hybridization and through induction of mutation. The newly developed yellow seeded short duration variety was found to be superior to BARI released variety BARImung-5 and BINA released variety BINAmung-7 with respect to yield potentiality and earliness. It matures eight days earlier than BARImung-5 and fourteen days earlier than BINAmung-7 (Table.7). In mung bean earliness is usually described by days from planting to opening of the first flower, or days to ripening of the first pod (Poehlman 1991). Imrie and Butler (1982) postulated that earliest flowering accessions are often the lowest yielding but in *YS-I*, plants having moderate yield was recorded (seed yield/plant of *YS-I*, BARImung-5 and

Binamung-7 was recorded as 11.15, 7.00 and 5.85 g respectively). In *YS-I* almost 51.23% increased yield was observed than BARI mung-5 and 92.09% yield enhancement was recorded against BINAmung-7 (Table. 7). Actually owing to the dwarf, bushy and compact plant architecture of *YS-I*, relatively more no. of plants could be accommodated in the same area for cultivation than the other two varieties. Determinate type plants with light green foliage were noticed in *YS-I* while the plants of BARImung-5 were though determinate, but its foliage was green. In contrast, BINA mung-7 plants were semi indeterminate type with green foliage. Light green plants normally tend to get senescence earlier and since *YS-I* being characterized by light green coloured foliage, its fruits ripened earlier and the plants became old quicker than BARImung-5 and BINAmung-7. Biswas (1998) earlier recovered a yellow seeded grass pea mutant through seed treatment with gamma ray which exhibited earliness in flowering and crop maturity as well. Synchronous ripening of fruits is desirable as pod picking can be completed earlier in these plants than asynchronous type which also minimizes the pod harvesting cost. In the yellow seeded mung bean almost all the pods could be harvested in two pickings only while in BARImung-5 and BINAmung-7 harvesting could be finished in more than two pickings. In mung bean growing areas where seeds are sown in the late summer; longer duration varieties suffer badly by the rain resulting to crop damage in the years when early monsoon arrives. In those areas short duration variety like *YS-I* may escape this type of crop failure. Mung bean growers prefer moderate size seeds having good physical appearance as market price of medium or small size mung bean of shining colour fetches relatively higher price than larger grains. *YS*-I being a variety having shining golden yellow coloured medium size seeds; it's seed has been found to be more acceptable to the growers and consumers as well. Moreover, since *YS-I* is insensitive to seasonal influence, it can be cultivated easily in the existing cropping pattern in mungbean growing areas. On the other hand, golden yellow colored seeded traditional variety *'Sonamoog'* was found to be seasonally sensitive and it's cultivation was restricted to Kharif-2 season only (July – October). In mung bean, selection of pure lines from mixed population was an early breeding procedure for its improvement and isolated lines with 24 per cent increased yield has been reported earlier (Bosch and Van den 1987a & 1987b). An indeterminate fodder type yellow mung bean variety with shattering characteristics and very recently a yellow seeded grass pea mutant with pod shattering characteristics has also been reported (Yan *et al.*1991, Talukdar *et al.* 2001). In contrast *YS-I* is a non shattering type of yellow seeded mung bean line. Through pure line selection from the heterogenous populations excellent varieties have also been isolated in a good number of crops like paddy, wheat, barley, peanut, chickpea, blackgram, greengram, pigeonpea, linseed, cowpea etc. (Singh 1996). To combat terminal heat stress during summer season and pre-harvest sprouting during rainy season in the major production base two super early genotypes of mung bean have been developed very recently by Pratap *et al.*(2013). It is interesting to note that near about 35.77% and 30.08% reduced amount of fat was recorded in *YS-I* than BARImung-5 and BINAmung-7 respectively. Low fat diet is desirable to prevent obesity as well as to control the cholesterol level and mung bean with low fat content will be more suitable for the preparation of confectionery products like '*Dhal Bhaja*' where the dehusked seeds are usually fried with oil. Slightly lower fat level (13.03%) of a yellow seeded mung bean variety has also been reported in the Phillipines (Landerito *et al*. 1993). Critical observation revealed that the testa of yellow seeded variety *YS-I* was very thin which not only ensures better pulse recovery it also enhances the permeability of water during seed germination and seedling emergence.

CONCLUSION

Mung bean seeds are very popular among the vegetarian people due to its high protein content, good flavour and excellent taste besides its use in the food processing industries. The newly developed yellow seeded mung bean *YS-I* has been found to be a determinate type virus tolerant high yielding variety with relatively shorter duration of maturity. It has also been found to be insensitive to seasonal influence and can be grown almost throughout the year. Besides its seed's good luster, better taste and good cooking quality; it has also lower amount of fat and has fair amount of different important minerals like calcium, phosphorus etc. Eating low fat mung bean is recommended for diabetics and for people suffering from problems related to high cholesterol levels as well as obesity and *YS-I* may be a good variety for the growing new demand of nutritious mung bean.

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