INFLUENCE OF SEED SIZE AND SEED TREATMENT ON QUALITY AND YIELD OF MUNGBEAN

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CERTIFICATE

*This is to certify that the thesis entitled "**INFLUENCE OF SEED SIZE AND SEED TREATMENT ON QUALITY AND YIELD OF MUNGBEAN**" submitted to the Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **SEED TECHNOLOGY,** embodies the results of a piece of bona fide research work carried out by **REDWANA FERDOUS,** Registration. No. **15-06993** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

Dated:

Dhaka, Bangladesh

(Prof. Dr. Parimal Kanti Biswas)
Supervisor

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ABSTRACT

A field experiment was conducted to study the influence of seed size and seed treatment on quality and yield of mungbean at the central experimental farm, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during August to November, 2016. Treatments consisted of three different seed sizes (S_1= Composite, S_2= Large and S_3= Small), two levels of red chili powder (P_0= Control, P_1= 1g per kg seed) and two levels of bleaching powder (B_0= Control, B_1= 2g per kg seed). Result revealed that vegetative growth i.e. plant height, number of leaves, plant dry weight, nodule numbers, number of branches; and yield and yield contributing characters i.e. pods number, pods length, number of seeds pod^{-1}, 1000 seeds weight of mungbean was significantly influenced by seed size, red chili powder and bleaching powder.The treatments S_2, P_1, B_1, S_2P_1, S_2B_1, P_1B_1 and $S_2P_1B_1$ gave the highest vegetative growth, reproductive development and seed yield (1092.86, 1123.78, 1095.64, 1394.99, 1403.53, 1358.53 and 1932.67 kg ha^{-1}, respectively). The highest pods and seed yield of the interaction treatment was attributed to the highest number of pods plant^{-1}, pod weight plant^{-1}, 1000 seeds weight. So, the applicationof red chili powder and bleaching powder and improvement of vegetative and reproductive development is attributed to the seed quality. Thus, it can be concluded that the application of red chili powder and bleaching powder had a positive impact on larger seeds size of mungbean.

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LIST OF ACRONYMS

AEZ	=Agro-Ecological Zone
BARI	= Bangladesh Agricultural Research Institute
BAU	= Bangladesh Agricultural University
BBS	= Bangladesh Bureau of Statistics
Co	= Cobalt
CV%	= Percentage of coefficient of variance
cv.	= Cultivar
DAE	= Department of Agricultural Extension
DAS	= Days after sowing
^{0}C	= Degree Celsius
et al	=And others
FAO	= Food and Agriculture Organization
g	= gram(s)
ha^{-1}	= Per hectare
HI	= Harvest Index
kg	=Kilogram
Max	= Maximum
mg	= milligram
Min	= Minimum
MP	= Muriateof Potash
N	=Nitrogen
No.	= Number
NPK	= Nitrogen, Phosphorus and Potassium
NS	= Not significant
%	= Percent
SAU	= Sher-e-Bangla Agricultural University
SRDI	= Soil Resources and Development Institute
TSP	= Triple Super Phosphate
Wt.	= Weight

CHAPTAR I

INTRODUCTION

Mungbean (*Vigna radiata* L.) is one of the leading pulse crop of Bangladesh. This pulse crop belongs to the family Fabaceae. It ranks 2nd position in price but in respect of acreages and production, it ranks 3rd position in Bangladesh (BBS, 2008). According to FAO (1999) recommendation, per capita requirement of pulse is 80g/head/day, whereas it is only 10g/head/day in Bangladesh (BBS, 2006). It is one of the most important pulse crop in our country for its high digestibility, good flavor and high protein content. Its seed contain 51% carbohydrate, 26% protein, 3% minerals and 3% vitamins (Kaul, 1982). It covers an area of 59717 acres and production is about 20628 metric tons (BBS, 2008).

Mungbean is very rich in protein and it complements the staple rice in Asian diets (AVRDC, 1998) one important factor of successfully growing of mungbean is the good available its seed. Seed size involves differences not only in weight and volume but also on stage of development of the mother plant. Plans from large seed have better chance of survivality than those from smalls one (Haper and Beton, 1966).The physiological seed qualities (i.e germination and vigour) and chemical composition are genetically controlled and are affected by environmental situation during the growing period of the crop (Cox *et al.*, 1985).In principle, seed size has effects on many characters both in the field and laboratory tests.Different seed sizes of a cultivar having different levels of starch and other food storage may be one factor which

influence the expression of physiological-dependent character (Chiangmai *et al*., 2000).

Amin (1999) reported that 50 per cent of large seeded mungbean matured earlier than that of small seeded ones. Large seed had an advantage of increased seedling vigour (Burries *et al*., 1973). According to Chistensen(1973), fungi that invade seeds can be divided into two general groups, field fungi and storage fungi. Storage fungi are those that grow on seeds or other kinds of materials while in storage.they have the ability to grow without free water (Wan Zainun and Parbery, 1971).Mixing chemical with seed can prevent deterioration of mungbean seed, prevent from fungi and increasing seed vigour and viability.

The larger seed size had a profound effect on growth and development of mungbean. The germination parameters were significantly related by seed weight and large seeds germinated early and showed better germination than small seeds of lentil (Hojjat, 2011). The highest vegetative growth i.e. plant height, number of leaves, total dry mater production and yield was obtained from sowing large sized seed (Kabir, 2000).

Plant extract helped to reduce to disease and insect attract. It also had positive effect on vegetative growth, reproductive development and quality improvement of seeds of mungbean. Different types of plant extract including hot chili powder enhanced the seed vigor and viability (Lone *et al*., 2014). Seed

treatment with hot chili powder increased the seed germination and field performance (vegetative and reproductive development) of plant (Patra, 2017). Different types of micronutrient helped to improve the normal growth and development of legume crops. Though micronutrient needed by plant in a small quantity, but it had different external and internal influence on plant growth. Yield and quality of mungbean highly depended on micronutrient application. Growth characteristics and yield of mungbean was positively influenced by calcium application in mungbean (Kumar *et al*., 2010).

Therefore, the present experiment was conducted to find out the actual seed size and optimum level of red chili powder and bleaching powder application in storage condition. Thus, the present study was carried out by the following objectives

1. To find out the influence of seed size on yield and quality of mungbean.
2. To check the optimum level of red chili powder on yield and quality of mungbean.
3. To check tout the optimum level of bleaching powder on yield and quality of mungbean.
4. To find out the combine effect seed size, red chili powder and bleaching powder on growth, yield and quality of mungbean.

CHAPTER 2

REVIEW OF LITERATURE

A field experiment was conducted at the Sher-e-Bangla Agricultural University farm to study the effect of influence of seed size and seed treatment on quality and yield of mungbean. Some related research findings of different researchers of home and abroad have been discussed below:

2.1. Effect of seed size

Hojjat (2011) reported that the germination parameters were significantly related by seed weight and large seeds germinated early and showed better germination than small seeds of Lentil genotypes. However, the studies of Kaydan and Yagmur (2008) on Triticale showed that the seedling growth of larger seeds was higher rather than of small seeds.

Mut and Akay (2010) reported that decreasing the seed size can cause to decrease the germination percentage, root and shoot length of Naked oat. An experiment was conducted with soybean to examine the effect of different seed size (small, medium and large). In that experiment, it was found that with increasing the seed size, plant height was found to be

increased significantly. The highest plant height was obtained from sowing large sized seed (Kabir, 2000).

Number of leaves plant^{-1} was examined under different seed size of soybean (Kabir, 2000). Results showed that the seed size had no significant effect on number of leaves plant^{-1}. But, with increasing the seed size, the number of leaves per plant was found to be increased. The highest number of leaves per plant was obtained from using the large sized seed and the lowest number was found using small seeds.

Kabir (2000) reported that the shoot dry weight of soybean increased significantly due to the sowing of large sized seeds. In another experiment, Kabir (2000) found that seed size (small, medium and large) had significant effect on total dry weight showing the highest dry weight from using the large sized seeds.

The highest number of pods plant^{-1} of soybean was obtained using the large sized seeds (Kabir 2000). It was also seen that with increasing the seed size and decreasing the sowing depth, number of pods plant-1 of soybean was found to be decreased. The highest number of pods plant^{-1} was obtained from using the large sized seeds when sown in 2 cm depth (Islam, 2004). Kabir (2000) stated that seed size of soybean had

significant effect on number of seed per pod. In his study, it was seed that the highest number of seeds per

pod was obtained from using the large sized seeds. Likewise, Islam (2004) reported that with increasing the seed size, number of seeds per pod of mungbean was increased.

The highest 1000 seeds weight was obtained when large sized seeds were sown (Kabir, 2000). Similar result was also obtained by Islam (2004) who worked with mungbean. Vishvanath *et al*. (2006) noticed significantly higher seed quality parameters viz. 100 seed weight, field emergence, seedling length, vigour index with the increase in sieve size in french bean.

Pedersen (2006) reported that smaller and larger seeds of a same variety will have the same yield potential of soybean. Gan *et al*. (2003) postulated that seed size had no significant impact on plant growth, development and seed yield of large-seeded crops such as chickpeas. However, in other crops, Stougaard and Xue (2005) reported that the use of higher larger seed sizes improved yields by 18%, and the use of small seeds reduced yield by 16% in wheat. This was also reported by Royo *et al*. (2006). In chickpea and lentil, were observed that plants from large

seeds yielded 6% more than medium seeds and 10% more than mixed seeds (Bicer, 2009).

In soybean, Kabir (2000) found that seed size had significant effect on harvest index. With increasing the seed size, the harvest index was increased. In that study, it was also found that sowing different sized seeds affected differently when sown at different depth. In another study, Islam (2004), however, found that seed size had no significant effect on harvest index although, with increasing the seed size, harvest index was found to be increased.

2.2. Effect of plant extract

Lone *et al*. (2014) conducted research and found that different types of plant extract including hot chili powder enhanced the seed vigor and viability. Seed treatment with hot chili powder increased the seed germination and field performance (vegetative and reproductive development) of plant (Patra, 2017).

An experiment was conducted to find out the bioactivity of four plant extracts on legumes crops in Nigeria and they found that it helped to control the storage pests and increase the germination percentages (Adedire and Akinkurolere, 2005).

Hossain *et al.* (2010) conducted an experiment to evaluate the effect of plant extracts, insecticides and cultural practices on growth characters and disease severity of mungbean yellow mosaic and they found that different types of plant extracts helped to control the yellow Mosaic Virus and moderately increased plant height, number of branches plant^{-1}, number of pods plant^{-1} and pod length.

2.3. Effect of Calcium

Kumar*et al*. (2010) conducted an experiment on growth characteristics and yield of mungbean (*Vigna radiata* L.) and found highest plant height due to calcium application. The maximum number of leaves, number of branches and highest dry weightwas found due to the calcium application in mungbean (*Vigna radiata* L.).

Yadav *et al*. (2014) conducted a research work to investigate the effect of gypsum on growth and yield of legume crops and reported that maximum nodules plant^{-1} was counted from calcium application area.

An experiment was conducted by Kumar*et al*. (2010) to find out the effect of calcium on mungbean and they reported that it enhanced the reproductive development of mungbean plant. The highest number of

pods, 1000 seeds weight, seed yield was found due to calcium application in mungbean (Kumar *et al*., 2010). A field experiment was carried out by to find out the effect of calcium on mungbean and they observed that it increased the number of pods plant^{-1} of mungbean.

An experiment was conducted to find out the effect of lime, magnesium and boron on wheat (*Triticum aestivum* L.) and their residual effects on mungbean (*Vigna radiata* L.) and they found that height pod length, number of seeds pod^{-1}, and seed yield was recorded from calcium (lime) treated plots (Hossain *et al*., 2013).Pathak (2010) found that with the application of calcium (Source: gypsum) pod length of legume (groundnut) was increased. Stover yield, biological yield, harvest index was highest due to application of lime (Hossain *et al*., 2013).

So, this research review's purpose will help readers to understand the influence of seed size and seed treatment on quality and yield of mungbean. These above reviews indicated that, worlds are working to improve the seed quality and yield of mungbean by different treatment procedure specially, bleaching powder and red chili powder. A lot of research related to the present study have been conducted worldwide, but in Bangladesh there have scanty of research. So, it is important to study

the influence of seed size and seed treatment on quality and yield of mungbean in Bangladesh. Thus this present study was conducted.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from August to November, 2016. Detailed of the experimental materials and methods followed in the study are presented in this chapter. The experiment was conducted to study the seed invigoration treatments in different seed size of mungbean for maintenance of vigour, viability and yield potential.

3.1 Site description

3.1.1 Geographical location

The experimental area was situated at 23°77′N latitude and 90°33′E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004).

3.1.2 Agro-ecological region

The experimental field belongs to the Agro-ecological zone of “The Modhupur Tract”, AEZ-28 (Anon., 1988a). This was a region of complex relief and soils developed over the Modhupur clay, where flood plain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as ‘islands’ surrounded by floodplain (Anon., 1988b).

3.1.3 Climate

The area has sub-tropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season (April-September) and scanty rainfall associated with moderately low temperature during the Rabi season (October-March). Weather information regarding temperature, relative humidity and rainfall prevailed at the experimental site during the study period were presented in Appendix I.

3.1.4 Soil

The soil of the experimental site belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH ranged from 5.6-6.5 and had organic matter 1.10-1.99%. The experimental area was flat having available irrigation and drainage system and above flood level. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done by Soil Resource and Development Institute (SRDI), Dhaka. The physical and chemical properties of the soil were presented in Appendix II.

3.2 Details of the experiment

3.2.1 Treatments

The experiment consisted of 3 factors:

Factors A: Levels of seed size

There were three level of seed size. There were-

(a) S_1 = Composite
(b) S_2 = Large
(c) S_3= Small

Factors B: Levels of red chili powder

There were two level of red chili powder. There were-

(a) P_0 = 0 (Control)
(b) P_1 = 1g per kg seed

Factors C: Bleaching powder

There were two level of bleaching powder under the study and they were-

(a) B_0= Control
(b) B_1= 2g per kg seed

3.2.2 Experimental design and layout

The experiment was laid out in a factorialRCBD design with three replications. There were 12 treatment combinations. The total numbers of unit plots were 36. The size of unit plot was 20.5 m × 18.5 m. The distances between plot to plot and replication to replication were 0.75 m and 1.0 m, respectively.

3.3 Crop/Planting Material

BARI mung 6 were used as plant material.

3.3.1 Description of crop: Variety (BARI mung 6)

The seeds of BARI mung 6, a modern mungbean variety was used as experimental material. BARI mung 6 was developed by Bangladesh Agricultural Research Institute (BARI). The plants life cycle lasts for 55-58 days and synchronous type. The plants are erect, stiff and less branched. Each plant contains 15-20 pods. Each pod is around 10 cm long and contains 8-10 seeds. Seeds are large and green in colour and drum shaped. The seed yield of BARI mung 6 range from 1.4-1.5 t ha^{-1}.

3.3.2 Description ofRecommended chemical fertilizer

The recommended chemical fertilizer dose was 50, 100, 55 and 1 kg ha^{-1} of Urea, TSP, MOP and BA respectively (Hussain *et al*., 2006). All the fertilizers along with half of urea were applied by broadcasting and was mixed with soil thoroughly at the time of final land preparation after making plot.

3.3.3 Description ofred chili powdermanagement

The red chili powder was appliedin a seed in storage for 6 months.The seeds of different sizes were stored in the tin container where red chili powder was mixed as per the treatments and maintained properly.

3.3.4 Description ofbleaching powder management

The seed was stored by applying bleaching powderfor 6 months.The seeds of different sizes were stored in the tin container where bleaching powder was mixed as per the treatments and maintained properly.Red chili powder and bleaching were also applied combinedly. Then after germination test was done and found above 80% germination.

3.4 Crop management

3.4.1 Seed collection

Seeds of BARI mung 6were collected from Pulse Seed Section, BARI, Joydebpur, Gazipur, Bangladesh.

3.4.2 Seed sowing

The seeds of BARI mung 6 having more than 80% germination were sown by hand in 30 cm apart from lines with continuous spacing at about 3 cm depth at the rate of 40 g $plot^{-1}$ on 15 August, 2016.

3.4.3 Collection and preparation of initial soil sample

The soil sample of the experimental field was collected before fertilizer application. The initial soil samples were collected before land

preparation from a 0-15 cm soil depth. The samples were collected by an auger from different location covering the whole experimental plot and mixed thoroughly to make a composite sample. After collection of soil samples, the plant roots, leaves etc. were removed. Then the samples were air-dried and sieved through a 10-mesh sieve and stored in a clean plastic container for physical and chemical analysis.

3.4.4 Preparation of experimental land

A pre- sowing irrigation was given on 08 August, 2016. The land was open with the help of a tractor drawn disc harrow on 15August, 2016, then ploughed with rotary plough twice followed by laddering to achieve a medium tilth required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was made on August 15, 2014 according to experimental specification. Individual plots were cleaned and finally prepared the plot.

3.4.5 Fertilizer application

The specific plots area was fertilized @ 50, 100, 55 and 1 kg ha^{-1} of Urea, TSP, MOP, BA and 10 t ha^{-1} cowdung respectively. The entire amounts of triple super phosphate (TSP), muriate of potash (MOP), boric acid (BA) and cowdung along with half of urea were applied as basal dose at

final land preparation. The rest urea was applied by top dressing at 25 days after sowing.

3.4.6 Intercultural operations

3.4.6.1 Thinning

The plots were thinned out on 15 days after sowing to maintain a uniform plant stand.

3.4.6.2 Weeding

The crop was infested with some weeds during the early stage of crop establishment. Two hand weedings were done, first weeding was done at 15 days after sowing followed by second weeding at 15 days after first weeding.

3.4.6.3 Application of irrigation water

Irrigation water was added to each plot, first irrigation was done as pre-sowing and other two were given 2-3 days before weeding.

3.4.6.4 Drainage

There was a heavy rainfall during the experimental period. Drainage channel were properly prepared to easy and quick drained out of excess water.

3.4.6.5 Plant protection measures

The crop was infested by insects and diseases, those were effectively and timely controlled by applying recommended insecticides and fungicides.

3.4.7 Harvesting and post-harvest operation

Maturity of crop was determined when 80-90% of the pods become blackish in color. The harvesting of BARI mung 6 were done up to 01November, 2016. Five pre-selected plants per plot from which different yield attributing data were collected and 3.6m^2 areas from middle portion of each plot was separately harvested and bundled, properly tagged and then brought to the threshing floor for recording grain and straw yield. The grains were cleaned and sun dried to a moisture content of 12%. Straw was also sun dried properly. Finally grain and straw yields $plot^{-1}$ were determined and converted to kg ha^{-1}.

3.4.8 Recording of data

Emergence of plants were counted from starting to a constant number of plants m^{-2} area of each plot. Experimental data were determined from 15 days of growth duration and continued until harvest. Dry weights of plant

were collected by harvesting respective number of plants at different specific dates from the inner rows leaving border rows and harvest area for grain. The following data were recorded during the experimentation.

A. Crop growth characters

i. Plant emergence (%)

ii. Plant height (cm) at 15 days interval

iii. Leaves plant^{-1}(No.)at 15 days interval

iv. Plant dry weight (g) at 15 days interval

v. Number of nodules plant^{-1} at 15 days interval

vi. Dry weight of nodules plant^{-1} at 15 days interval

B. Yield and other crop characters

i. Number of branches plant^{-1}

ii. Number of pods plant^{-1}

iii. Length of pod (cm)

iv. Number of seeds pod^{-1}

v. Weight of 1000 seeds (g)

vi. Pod yield (kg ha^{-1})

vii. Seed yield (kg ha^{-1})

viii. Harvest index (%)

3.4.9 Detailed procedures of recording data

A brief outline of the data recording procedure followed during the study given below:

A. Crop growth characters

3.4.9.1 Plant emergence percentage

A $1m^2$ area of each plot was selected from where emerged plants were counted daily up to a constant number when germination stopped. The maximum number of germinated seeds was considered as 100% emergence.

3.4.9.2 Plant height

Plant height of 5 selected plants from each plot was measured at15, 30, 45 days after sowing (DAS) and at harvest. The height of the plant was determined by measuring the distance from the soil surface to the tip of the leaf of main shoot.

3.4.9.3 Number of leaves $plant^{-1}$

Leaves plant^{-1} of 5 selected plants from each plot was measured at15, 30, 45 days after sowing (DAS) and at harvest. The number of leaves plant^{-1} was determined and average together.

3.4.9.4 Dry weight of plant

The sub-samples of 5 plant plot^{-1} uprooted from second line were oven dried until a constant leveled, from which the weights of above ground dry matter were recorded at 15 days intervals and at harvest.

3.4.9.5Number of nodules

The 5 plants plot^{-1} from second line was uprooted with the help of spade. The roots of the sample plants were washed gently and total number of nodules from five plants was counted at 20, 35, 50 DAS and the mean value determined**.**

3.4.9.6 Nodules dry weight

Nodules were oven dried and then dry weight of nodules was measured in milligram.

B. Yield and other crop characters

3.4.9.7Number of branches plant^{-1}

Branches number was counted from ten pre-selected plants and the mean value was determined.

3.4.9.8 Pods plant^{-1}

Pods of ten selected plants were counted and the average pods for each plant was determined.

3.4.9.9 Pods length (cm)

The 10 pods were selected to measure the pod length and then averaged together.

3.4.9.10 Seeds pod^{-1}

Pods from each of ten plants plot^{-1} were separated from which ten pods were selected randomly. The number of seeds pod^{-1} was counted and average number of seeds pod^{-1} was determined.

3.4.9.11 Weight of 1000-seeds

One thousand cleaned dried seeds were counted randomly from each sample and weighed by using a digital electric balance at the stage the grain retained 12% moisture and the mean weight were expressed in gram.

3.4.9.12 Pod yield

Pod yield was determined from the central 3.1 m^2 area of each plot. After separation of pods, the sub-samples were oven dried to a constant weight and finally converted to kg ha^{-1}.

3.4.9.13Seed yield

Grain yield was determined from the central 3.6 m^2 area of each plot and expressed as t ha^{-1} and adjusted with 12% moisture basis. Moisture content was measured by using a digital moisture tester.

3.4.9.14Harvest index

Harvest index denotes the ratio of economic yield (seed yield) to biological yield and was calculated with following formula (Donald, 1963; Gardner *et al*., 1985).

$$\text{Harvest index (\%)} = \frac{Seed\ yield}{Biological\ yield} \times 100$$

3.4.11 Statistical analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique using a statistical computer software IBM-SPSS (Version 20.0) and the means were adjusted by Tukey's Test at 0.05% level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter represent the result and discussions of the present study. Summary of mean square values at different parameters are also given in the appendices from IV to XII.

4.1 Effect of seed size, red chili powder and bleaching powder on growth of mungbean

4.1.1 Emergence

4.1.1.1 Effect seed size

Seed size had a significant impact on percentage ofmungbean seedling emergence. Larger seed size produced highestpercentages of emergence (31.92%, 37.87%, 75.82%, 85.82%, 89.82%)where smaller seed produced 25.37%, 28.6%, 60.7%, 70.7%, 74.7% and composite produced28.56%, 34.26%, 67%, 77%, 81%of emergence at 2^{nd}, 3^{rd}, 4^{th}, 5^{th} and 6^{th} DAS, respectively(Figure 1 and appendix III). This might be due to that larger seed size helped early germination and faster growth of hypocotyl.

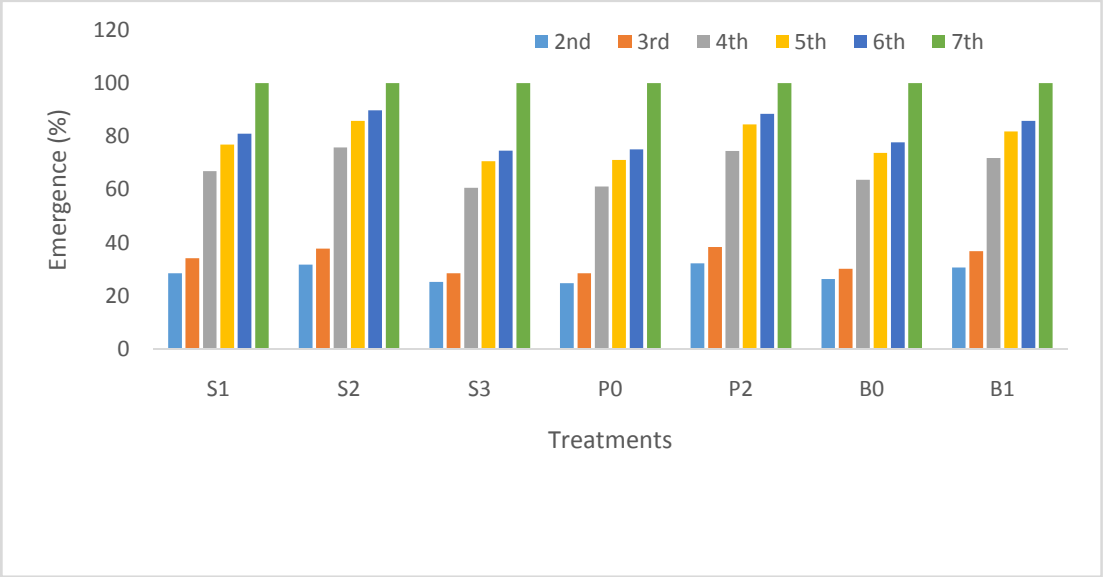
4.1.1.2 Effect of red chili powder

Seedling emergence showed significant variations with the application of red chili powder in storage condition. Data revealed that 1g per kg seed produced the highest germination percentage (32.36%, 38.50%, 74.52%, 84.52%, 88.52%) over the control (24.88%, 28.66%, 61.16%, 71.16%, 75.16%) at 2^{nd}, 3^{rd}, 4^{th}, 5^{th} and 6^{th} DAS, respectively(Figure 2 and appendix III). This might be due to red chili powder had pronounced effect of faster seedling germination as reported by lone *et al*. (2014) and patra (2017).

4.1.1.3 Effect of bleaching powder

A positively significant variation was observed due to the application of bleaching powder on storage condition (Figure 3 and appendix III). Seed stored with bleaching powder treated gave the highest germination percentage

(30.82%, 36.88%, 71.91%, 81.91%, 85.91%) over the control (26.42%, 30.28%, 63.77%, 73.77%, 77.77%) at 2nd, 3rd, 4th, 5th and 6th DAS, respectively. The possible reason behind the finding is calcium helped to enhance the faster growth of hypocotyl of mungbean. The result was as per with the finding of Kumar et al. (2010) and Pathak (2010).



S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g per kg seed; B_0= control, B_1= 2g per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 1. Effect of Seed size, red chili powder and bleaching powder on emergence of mungbean

4.1.1.4 Interaction effect of seed size and red chili powder

Interaction effect of seed size and red chili powder showed significant result only at 2nd and 3rd DAS but rest of sampling dates it had non-significant impact on germination percentages (Table 1 and appendix III).

Table 1. Interaction effect of seed size and red chili powder on emergenceof mungbean

Treatments	Percentemergence (days) at					
	2nd	3rd	4th	5th	6th	7th
S_1P_0	24.62	29.82	60.57	70.57	74.57	100
S_1P_1	32.51	38.72	73.43	83.43	87.43	100
S_2P_0	29.62	33.43	70.65	80.65	84.65	100
S_2P_1	34.22	42.30	80.98	90.98	94.98	100
S_3P_0	20.39	22.72	52.26	62.26	66.26	100
S_3P_1	30.35	34.48	69.14	79.14	83.14	100
SE (±)	0.500	2.455	NS	NS	NS	NS
CV (%)	4.35	3.25	8.64	7.53	7.16	-

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powderperkg seed. Means were separated by Tukey's test at $P \leq 0.05$. NS=non-significant.

4.1.1.5 Interaction effect of seed size and bleaching powder

Seed size and bleaching powder showed non-significant impact of germination percentages of mungbean at all sampling dates except at 2nd DAS (Table 2 and appendix III).

Table 2. Interaction effect of seed size and bleaching powder on emergence of mungbean

Treatment	Percent emergence (days) at					
	2nd	3rd	4th	5th	6th	7th
S_1B_0	25.78	31.71	61.73	71.73	75.73	100
S_1B_1	31.34	36.82	72.27	82.27	86.27	100
S_2B_0	30.60	34.53	72.88	82.88	86.88	100
S_2B_1	33.23	41.20	78.75	88.75	92.75	100
S_3B_0	22.87	24.58	56.68	66.68	70.68	100
S_3B_1	27.88	32.61	64.72	74.72	78.72	100
SE (±)	0.500	NS	NS	NS	NS	NS
CV (%)	4.35	3.25	8.64	7.53	7.16	-

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder perkg seed. Means were separated by Tukey's test at $P \leq 0.05$. NS=non-significant.

4.1.1.6Interaction effect of red chili powder and bleaching powder

From data (Table 3and appendix III) it was found that P_1B_1 gave the best result compared to other interactions. This interaction produced highest germination percentages over other combinationsat all sampling dates but at 2nd and 7th DAS it showed non-significant result.

Table 3. Interaction effect red chili powder and bleaching powder on emergence of mungbean

Treatment	Percentemergence (Days) at					
	2nd	3rd	4th	5th	6th	7th
P_0B_0	22.33	27.06	59.36	69.36	73.36	100
P_0B_1	27.42	30.26	62.96	72.96	76.96	100
P_1B_0	30.50	33.50	68.17	78.17	82.17	100
P_1B_1	34.22	43.49	80.87	90.87	94.87	100
SE (±)	NS	0.395	2.005	2.005	2.005	NS
CV (%)	4.35	3.25	8.64	7.53	7.16	-

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder perkg seed. Means were separated by Tukey's test at $P \leq 0.05$. NS=non-significant.

4.1.1.5 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of $S_2P_1B_1$ (seed size, red chili powder and bleaching powder) gave the best result compared to other interactions (Table 4and appendix III). This interaction produced 35.60%, 48.03%, 85.53%, 95.53%, 99.53% emergences at 2nd, 3rd, 4th, 5th and 6th DAS, respectively. But statistic showed non-significant at all sampling dates except 3rd DAS.

Table 4. Interaction effect of seed size, red chili powder and bleaching powder on emergence of mungbean

Treatment	Percentemergence (days) at					
	2nd	3rd	4th	5th	6th	7th
$S_1P_0B_0$	21.07	28.30	58.10	68.10	72.10	100
$S_1P_0B_1$	28.17	31.33	63.03	73.03	77.03	100
$S_1P_1B_0$	30.50	35.12	65.37	75.37	79.37	100
$S_1P_1B_1$	34.52	42.30	81.50	91.50	95.50	100
$S_2P_0B_0$	28.37	32.50	69.33	79.33	83.33	100
$S_2P_0B_1$	30.87	34.37	71.97	81.97	85.96	100
$S_2P_1B_0$	32.83	36.57	76.43	86.43	90.43	100
$S_2P_1B_1$	35.60	48.03	85.53	95.53	99.53	100
$S_3P_0B_0$	17.57	20.37	50.64	60.64	64.64	100
$S_3P_0B_1$	23.22	25.07	53.88	63.88	67.88	100
$S_3P_1B_0$	28.17	28.80	62.72	72.72	76.72	100
$S_3P_1B_1$	32.53	40.16	75.57	85.57	89.57	100
SE (±)	NS	0.684	NS	NS	NS	NS
CV (%)	4.35	3.25	8.64	7.53	7.16	-

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder perkg seed. Means were separated by Tukey's test at $P \leq 0.05$. NS=non-significant.

4.1.2 Plant height

4.1.2.1 Effect of seed size

Plant height increased gradually with the advancement of growth stage and up to harvest. The highest plant height was obtained from the larger seed (16.86, 56.56, 67.33 and 74.88 cm at 15, 30, 45DAS and during harvest, respectively) over the composite and smaller seed size (Figure 2 and appendix IV). The fact that plant growth rate was significantly influenced by seed size in mungbean.

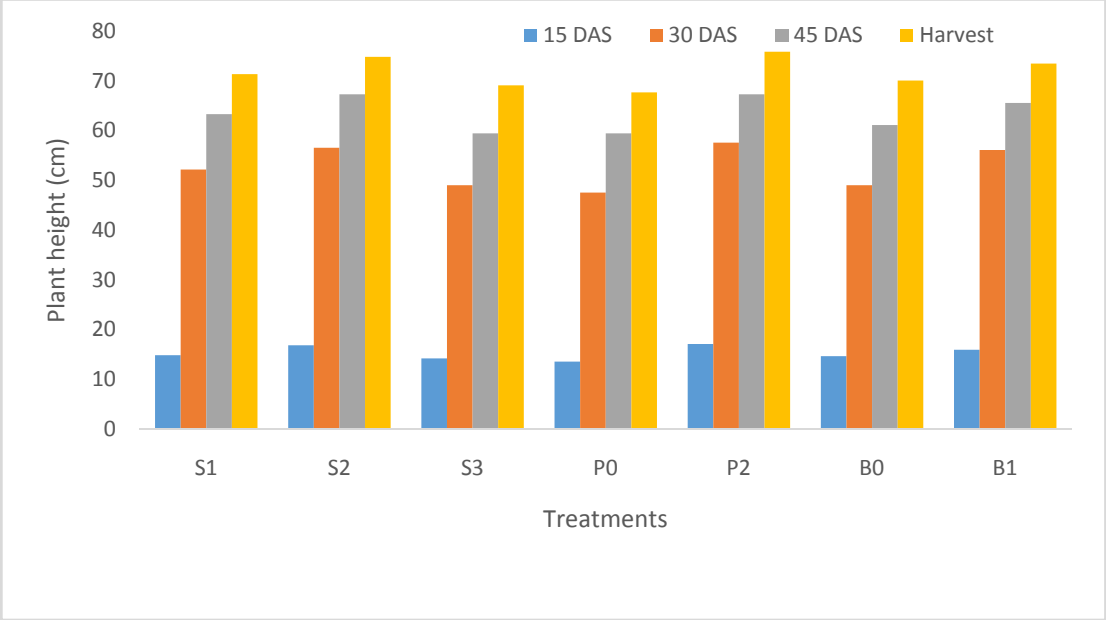
4.1.2.2 Effect of red chili powder

Plant height showed significant variations with the application of different doses of red chili powder in storage condition. Data revealed that 1g per kg seed red chili powder produced the highest plant height over the control at 15, 30, 45 DAS and during harvest time (Figure 2 and appendix IV). This might be due to that red chili powder helped to cell elongation and meristematic tissue

development in plant. It was also reported that vegetative growth increased with the application of plant extract in mungbean (Patra, 2017).

4.1.2.3 Effect of bleaching powder

Bleaching powder treated seed produced the highest plant height (14.48, 44.74, 86.86 and 102.90 cm) while control showed the lowest and identical plant height (15.94, 56.13, 65.61 and 73.53 cm) at 15, 30, 45 DAS and at harvest time, respectively (Figure 2 and appendix IV). This might be due to the application of calcium in storage condition. The present finding is consisted with the findings of Kumar *et al*. (2010).



DAS= Days After Sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 2. Effect of seed size, red chili powder and bleaching powder on the plant heightofmungbean

4.1.2.4 Interaction effect of seed size and red chili powder

A significant variation was observed in terms of plant height due to interaction of seed size and red chili powder at all sampling dates except 30 DAS (Table 5and appendixIV). The highest plant height was recorded from S_2P_1interaction compared to others.

Table 5. Interaction effect of seed size and red chili powder on plant height of mungbean

Treatments	Plant height (cm) at			
	15 DAS	30 DAS	45 DAS	Harvest
S_1P_0	12.83	46.45	58.47	65.27
S_1P_1	16.90	57.88	68.25	77.53
S_2P_0	14.77	51.20	62.40	71.98
S_2P_1	18.95	61.92	72.25	77.77
S_3P_0	13.07	45.12	57.45	65.88
S_3P_1	15.42	52.97	61.43	72.35
SE (±)	0.309	NS	1.272	0.881
CV (%)	4.86	3.59	4.23	2.96

DAS= Days After Sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.2.5 Interaction effect of seed size and bleaching powder

There was no significant variation was observed between the interaction of seed size and bleaching powder treatment (Table 6and appendixIV).

Table 6.Interaction effect of seed size and bleaching powder on plant heightof mungbean

Treatments	Plant height (cm) at			
	15 DAS	30 DAS	45 DAS	Harvest
S_1B_0	14.45	48.18	60.87	70.02
S_1B_1	15.28	56.15	65.85	72.78
S_2B_0	16.10	52.47	64.08	72.50
S_2B_1	17.62	60.65	70.57	77.25
S_3B_0	13.55	46.48	58.47	67.68
S_3B_1	14.93	51.60	60.42	70.55
SE (±)	NS	NS	NS	NS
CV	4.86%	3.59%	4.23%	2.96%

DAS= Days After Sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.2.6Interaction effect of red chili powder and bleaching powder

Plant height showed non-significant variations with the application of different doses of red chili powder and bleaching powder interaction. Data revealed that interaction ofred chili powderand bleaching powder treated seed produced the tallest plant height over the other interactions at 15, 30, 45 DAS and during harvest time but at only 30 DASit showed a significant variation among the interactions (Table 7 and appendix IV).

Table 7. Effect of red chili powder and bleaching powder interaction on the plant height of mungbean

Treatment	Plant height (cm) at			
	15 DAS	30 DAS	45 DAS	Harvest
Red Chili Powder × Bleaching Powder (P × B)				
P_0B_0	12.96	45.81	57.94	66.22
P_0B_1	14.16	49.37	60.93	69.20
P_1B_0	16.44	52.28	64.33	73.91
P_1B_1	17.73	62.90	70.29	77.86
SE (±)	NS	0.611	NS	NS
CV (%)	4.86	3.59	4.23	2.96

DAS= Days After Sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.2.7 Interaction effect of seed size, red chili powder and bleaching powder

Interaction between seed size, red chili powder and bleaching powder was observed a positive effect on plant height only at 15 DAS. But data showed that there were no significant differences among the treatment interactions on plant height of mungbean at other sampling dates (Table 8 and appendix IV). Tallest plant was observed from $S_2P_1B_1$interaction at the entire growth stage and at harvest.

Table 8. Interaction effect of seed size, red chili powder and bleaching powder on the plant heightof mungbean

Treatment	Plant height (cm) at			
	15 DAS	30 DAS	45 DAS	Harvest
$S_1P_0B_0$	12.53	44.83	57.77	63.63
$S_1P_0B_1$	13.13	48.07	59.17	66.90
$S_1P_1B_0$	16.37	51.53	63.97	76.40
$S_1P_1B_1$	17.43	64.23	72.53	78.67
$S_2P_0B_0$	13.47	48.50	59.60	70.00
$S_2P_0B_1$	16.07	53.90	65.20	73.97
$S_2P_1B_0$	18.73	56.43	68.57	75.00
$S_2P_1B_1$	19.17	67.40	75.93	80.53
$S_3P_0B_0$	12.87	44.10	56.47	65.03
$S_3P_0B_1$	13.27	46.13	58.43	66.73
$S_3P_1B_0$	14.23	48.87	60.47	70.33
$S_3P_1B_1$	16.60	57.07	62.40	74.37
SE (±)	0.438	NS	NS	NS
CV (%)	4.86	3.59	4.23	2.96

DAS= Days After Sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.3Number of leaves plant^{-1}

4.1.3.1 Effect of seed size

Number of leaves of mungbean increased gradually with the advancement of growth stage up to certain days and then showed decreasing trend. The highest number of leaves was obtained from the largerseed size compared to other seed sizes at 15, 30, 45 DAS and at harvest (Figure 3 and appendix V).

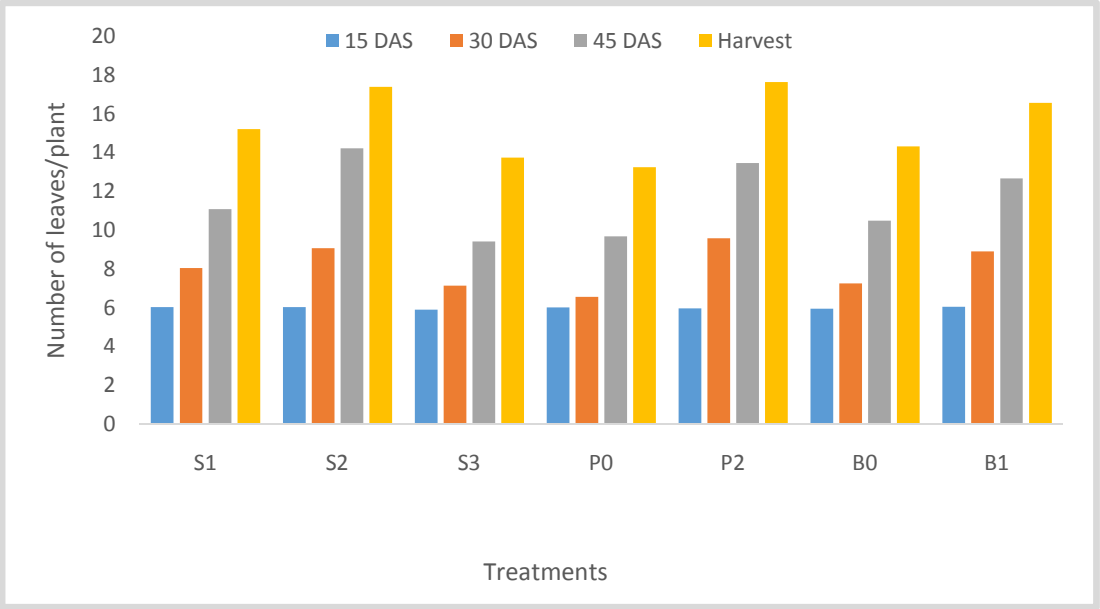
4.1.3.2 Effect of red chili powder

Number of leaves of mungbean varied significantly due to the effect of different doses of red chili powder application in storage condition (Figure 3 and appendix V). The data revealed that P_1treated seed produced the highest number of leaves and control produced the lowest number of leaves. Probably

red chili powderenhanced the vegetative growth of mungbean as reported byHossain *et al.* (2010).

4.1.3.3 Effect of bleaching powder

Bleaching powder treated seeds produced the highest number of leaves over the control at 15 DAS, 30 DAS, 45 DAS and at harvest (Figure 3 and appendix V). This might be due to bleaching powder (calcium) treated seed produced maximum number of leaves in mungbean (Kumar *et al*., 2010).



DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 3. Effect of seed size, red chili powder and bleaching powder on number of leaves of mungbean

4.1.3.4 Effect of seed size and red chili powder interaction

The interaction effect seed size and red chili produced thehighest number of leaves at all growth stages and at harvest (Table 9 and appendix V). Also, there was no significant effect of this interaction, but only at harvest it showed significant effect.

Table 9. Interaction effect of seed size and red chili powder on number of leaves of mungbean

Treatments	Number of leaves palnt^{-1} at			
	15 DAS	30 DAS	45 DAS	Harvest
S_1P_0	6.17	6.77	8.97	13.39
S_1P_1	5.93	9.35	13.23	17.05
S_2P_0	6.10	7.18	12.25	14.77
S_2P_1	6.00	10.97	16.20	20.03
S_3P_0	5.83	5.80	7.87	11.62
S_3P_1	6.00	8.50	11.00	15.88
SE (±)	NS	NS	NS	0.285
CV (%)	5.28%	8.07%	5.36%	4.14%

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.3.5 Interaction effect of seed sizeand bleaching powder

There was no significant effect of seed size and bleaching powder interaction on the number of leaves palnt^{-1} (Table 10 and appendix V).

Table 10. Interaction effect of seed size and bleaching powder on number of leaves palnt^{-1}of mungbean

Treatments	Number of leaves palnt^{-1} at			
	15 DAS	30 DAS	45 DAS	Harvest
S_1B_0	5.93	7.27	9.97	14.19
S_1B_1	5.17	8.85	12.23	16.25
S_2B_0	5.93	8.10	13.13	16.20
S_2B_1	6.17	10.05	15.32	18.60
S_3B_0	6.00	6.45	8.38	12.62
S_3B_1	5.83	7.85	10.48	14.88
SE (±)	NS	NS	NS	NS
CV (%)	5.28	8.07	5.36	4.14

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.3.6 Effect of red chili powder and bleaching powder interaction

Number of leaves of mungbean varied significantly with the application of different doses of red chili powder and bleaching powder in storage condition. Red chili powder and bleaching powder interaction had the significant effect at number of leaves plant^{-1}at 30 and 45 DAS but at 15 DAS and harvest it showed non-significant effect (Table 11 and appendix V). Data revealed that the P_1B_1 interaction gave the highest result at all sampling dates.

Table 11. Effect of red chili powder-bleaching powder interaction on number of leaves of mungbean

Treatments	Number of leaves at			
	15 DAS	30 DAS	45 DAS	Harvest
P_0B_0	5.96	6.14	8.83	12.14
P_0B_1	6.11	7.02	10.56	14.38
P_1B_0	5.96	8.40	12.16	16.53
P_1B_1	6.00	10.81	14.80	18.78
SE (±)	NS	0.220	0.214	NS
CV (%)	5.28	8.07	5.36	4.14

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.4.5 Interaction effect of seed size, red chili powder and bleaching powder

Interaction between seed size, red chili powder and bleaching powder had a non-significant effect on number of leaves. Data showed that the non-significant differences was observed in number of leaves of mungbean at all sampling dates (Table 12 and appendix V). In spite of having non-significant effect themaximumnumber of leaves was observed from $S_2P_1B_1$ treatment interaction compared to others interactions.

Table 12. Interaction effect of seed sizered chili powder and bleaching powder on number of leaves of mungbean

Treatments	Number of leaves at			
	15 DAS	30 DAS	45 DAS	Harvest
$S_1P_0B_0$	6.00	6.37	7.97	12.19
$S_1P_0B_1$	6.33	7.17	9.97	14.60
$S_1P_1B_0$	5.87	8.16	11.97	16.20
$S_1P_1B_1$	6.00	10.53	14.50	17.90
$S_2P_0B_0$	5.87	6.57	11.23	13.70
$S_2P_0B_1$	6.33	7.80	13.27	15.83
$S_2P_1B_0$	6.00	9.63	15.03	18.70
$S_2P_1B_1$	6.00	12.30	17.37	21.37
$S_3P_0B_0$	6.00	5.50	7.30	10.53
$S_3P_0B_1$	5.67	6.10	8.43	12.70
$S_3P_1B_0$	6.00	7.40	9.47	14.70
$S_3P_1B_1$	6.00	9.60	12.53	17.07
SE (±)	NS	NS	NS	NS
CV (%)	5.28	8.07	5.36	4.14

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.4 Plant dry weight

4.1.4.1 Effect of seed size

Significant variation for plant dry weight of mungbean at 15, 30, 45 DAS and at harvest were observed due to the seed size (Figure 4 and appendix VI). Larger seed size produced highest plant dry weight at all sampling dates over other seed sizes. The reason behind the result might be due to that larger seed size helped to increase the vegetative growth.

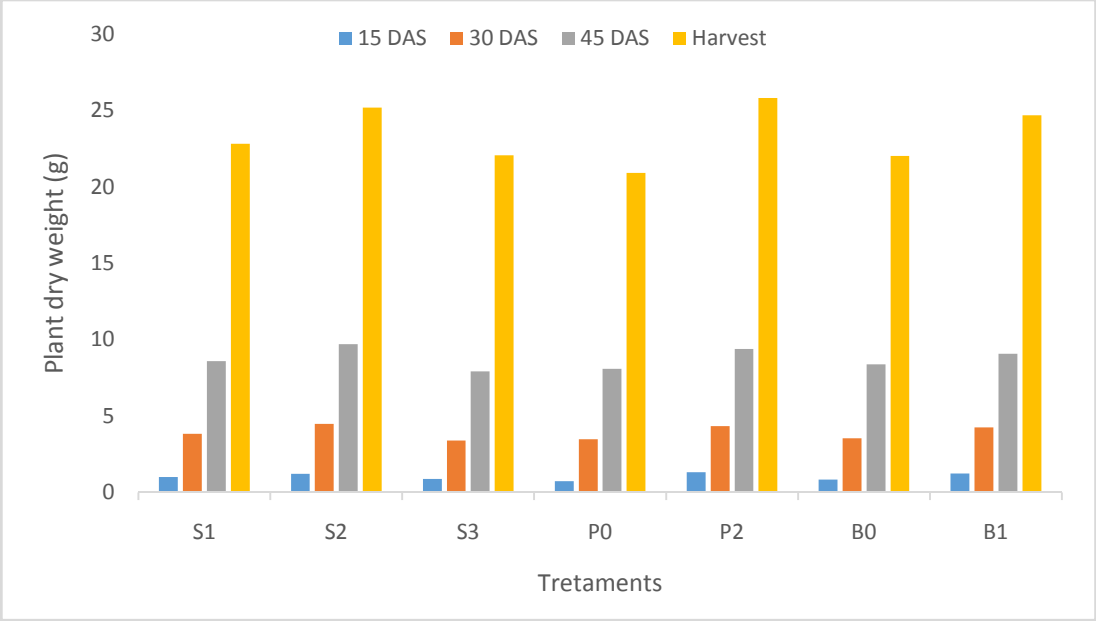
4.1.4.2 Effect of red chili powder

The shoot dry weight of mungbean at all sampling dates was influenced significantly due to different levels of red chili powder application in storage condition (Figure 4 and appendix VI). The highest plant dry weight produced from chili powder treated seedsand the lowest plant dry weight was observed from control treatment. This might be due to that red chili powder helped to

increase the dry weight of mungbean plant. Similar opinion was reported by lone *et al*. (2014) and patra (2017).

4.1.4.3 Effect of bleaching powder

Plant dry weight of mungbean increased as the age of the plants was increased up to the harvest. From the present study, significant variation was observed in terms of plant dry weight at all growth stages with bleaching powder treated seeds (Figure 4 and appendix VI). Kumar *et al*. (2010)also reported that plant dry weight increased with the application of calcium in mungbean.



DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 4. Effect of seed size, red chili powder and bleaching powderon plant dry weight plant^{-1} of mungbean

4.1.4.4 Interaction effect of seed size and red chili powder

There was no significant impact of interaction effect of seed size and red chili powder observed for dry weight of plant at all sampling dates except at harvest (Table 13and appendix VI). At harvest, the highest dry weight (26.68 g plnat^{-1}) was given by S_2P_1 (large seed with red chili powder treated) and the lowest (19.16 g plant^{-1}) dry weight was found in S_3P_0 combination.

Table 13. Interaction effect of seed size and red chili powder on dry weight of plant of mungbean

Treatments	Plant dry weight (g) at			
	15 DAS	30 DAS	45 DAS	Harvest
S_1P_0	0.72	3.38	7.78	19.86
S_1P_1	1.29	4.27	9.40	25.76
S_2P_0	0.84	4.01	9.07	23.68
S_2P_1	1.58	4.94	10.32	26.68
S_3P_0	0.62	3.00	7.38	19.16
S_3P_1	1.12	3.80	8.45	24.96
SE (±)	NS	NS	NS	0.161
CV (%)	12.14	9.83	4.78	1.73

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.4.5 Interaction effect of seed size and bleaching powder

Interaction effect of seed size and bleaching powder showed non-significant effect on dry weight of plant of mungbean (Table 14and appendixVI) for all the studied durations.

Table 14. Interaction effect of seed size and bleaching powder on plant dry weightof mungbean

Treatments	Plant dry weight (g) at			
	15 DAS	30 DAS	45 DAS	Harvest
S_1B_0	0.84	3.41	8.12	21.25
S_1B_1	1.76	4.24	9.06	24.37
S_2B_0	0.95	4.13	9.34	24.01
S_2B_1	1.46	4.82	10.05	26.34
S_3B_0	0.69	3.10	7.71	20.79
S_3B_1	1.05	3.70	8.11	23.34
SE (±)	NS	NS	NS	NS
CV (%)	12.14	9.83	4.78	1.73

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.4.6Interaction effect of red chili powder and bleaching powder

The plant dry weight of mungbean influenced significantly by the interaction of red chili powder and bleaching powder except 30 and 45DAS (Table 15 and appendix VI). The P_1B_1 interaction produced the highest plant dry weight(1.61 and 27.33 g plant-1 at 15 DAS and harvest, respectively) at all sampling dates.

Table 15. Interaction effect of red chili powder and bleaching powder on plant dry weightof mungbean

Treatments	Plant dry weight (g) at			
	15 DAS	30 DAS	45 DAS	Harvest
P_0B_0	0.61	3.21	7.74	19.76
P_0B_1	0.85	3.72	8.41	22.04
P_1B_0	1.05	3.88	9.03	24.27
P_1B_1	1.61	4.79	9.74	27.33
SE (±)	0.040	NS	NS	0.131
CV	12.14%	9.83%	4.78%	1.73%

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.4.7 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed size, red chili powder and bleaching powder not showed the wide range of significant variation at all sampling dates except at harvest (Table 16 and appendix VI). Larger seed, red chili powder and bleaching powder combination produced the highest shoot dry weight at all sampling dates compared than that of others interactions.

Table 16. Interaction effect of seed size-red chili powder-bleaching powder on shoot dry weight of mungbean

Treatments	Plant dry weight (g) at			
	15 DAS	30 DAS	45 DAS	Harvest
$S_1P_0B_0$	0.66	3.10	7.16	18.28
$S_1P_0B_1$	0.78	3.66	8.40	21.43
$S_1P_1B_0$	1.01	3.72	9.07	24.21
$S_1P_1B_1$	1.57	4.82	9.72	27.30
$S_2P_0B_0$	0.67	3.84	8.77	23.20
$S_2P_0B_1$	1.01	4.19	9.37	24.15
$S_2P_1B_0$	1.24	4.42	9.91	24.82
$S_2P_1B_1$	1.91	5.46	10.73	28.53
$S_3P_0B_0$	0.49	2.70	7.30	17.79
$S_3P_0B_1$	0.76	3.30	7.45	20.53
$S_3P_1B_0$	0.89	3.50	8.12	23.78
$S_3P_1B_1$	1.35	4.10	8.77	26.14
SE (±)	NS	NS	NS	0.227
CV (%)	12.14	9.83	4.78	1.73

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.5 Number of nodules plant^{-1}

4.1.5.1 Effect of seed size

The totalnumber of nodules plant^{-1} was significantly influenced for different seed sizes of mungbean throughout the growing season (Figure 5 and Appendix VII). The S_2 produced the maximum totalnumber of nodules plant^{-1} (25.41, 34.12, and 23.81 at 20, 35 and 50 DAS, respectively) compared to S_1 and S_3.

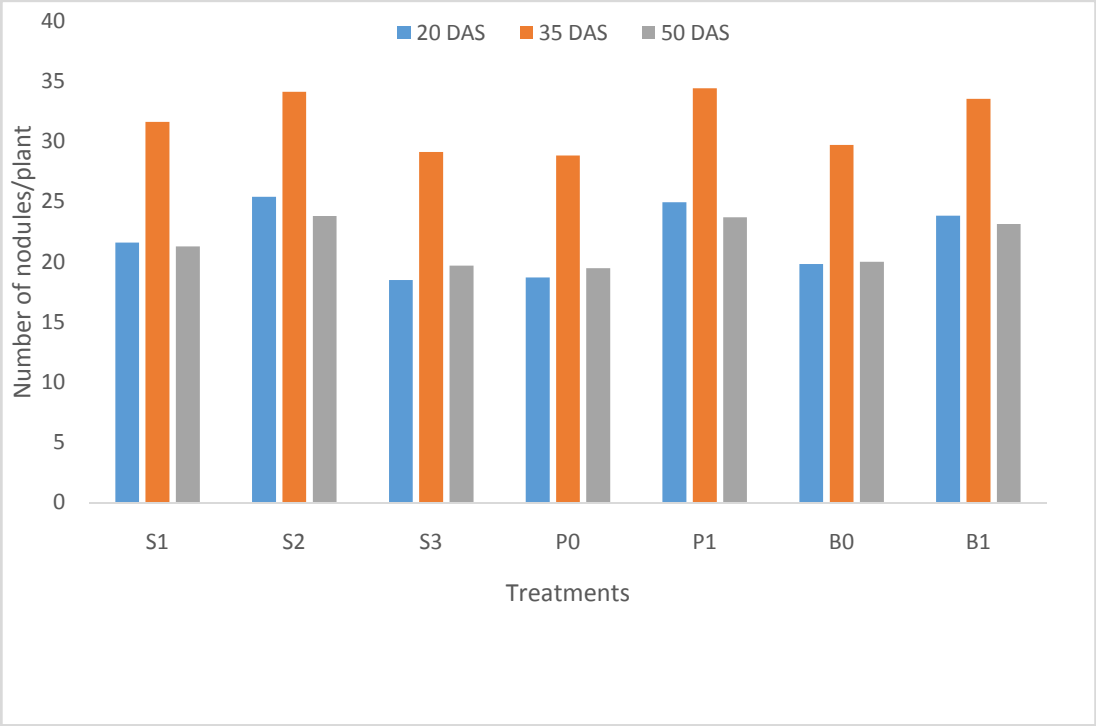
4.1.5.2 Effect of red chili powder

The red chili powder levels were highly significant effect in formation of totalnumber of nodules plant^{-1} recorded at 20, 35 and 50 DAS (Figure 5 and

Appendix VII). At 20, 35 and 50 DAS, the maximum totalnumber of maximum nodules plant^{-1} (24.97, 34.42 and 23.7, respectively) were produced by P_1 and lowest was produced by P_0.

4.1.5.3 Effect of bleaching powder

Number of nodules plant^{-1} of mungbean increased as the age of the plants was increased up to the harvest. From the present study, significant variation was observed in terms of number of nodules plant^{-1} at all growth stages (Figure 5 and Appendix VII)Yadav *et al*. (2014) also reported that plant dry weight increased with the application of calcium in mungbean.



DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 5. Effect of seed size, red chili powder and bleaching powder on nodules plant^{-1} of mungbean

4.1.5.4 Interaction effect of seed size and red chili powder

Interaction effect of seed size and red chili powder showed significant effect only at 15 DAS (Table 17 and appendix VII). The interactionS_2P_1produced the maximum number of nodules at all sampling dates.

Table 17. Interaction effect of seed size and red chili powder on number of nodules plant^{-1}of mungbean

Treatments	Number of nodules plant^{-1}at		
	20 DAS	35 DAS	50 DAS
S_1P_0	19.02	28.98	19.27
S_1P_1	24.19	34.25	23.30
S_2P_0	21.44	31.84	21.89
S_2P_1	29.38	36.41	25.73
S_3P_0	15.68	25.68	17.28
S_3P_1	21.33	32.59	22.09
SE (±)	0.492	NS	NS
CV (%)	5.39	3.75	6.84

DAS= Days After Sowing, S= seed size, S_1 = composite seed, S_2 = large seed, S_3= small seed; P= red chili powder, B= bleaching powder, P_0=control, P_1= 1g per kg seed; B_0= control, B_1= 2g per kg seed. Means were separated by Tukey's test at $P \leq 0.05$. NS=non-significant. *means significant at $p \leq 0.05$.

4.1.5.5 Interaction effect of seed size and bleaching powder

Interaction effect of seed size and bleaching powder showed non-significant effect at all sampling dates except at 15 DAS (Table 18 andappendix VII). The interactionS_2B_1produced the maximum number of nodules at all sampling dates.

Table 18. Interaction effect of seed size and bleaching powder on number of nodules plant^{-1}of mungbean

Treatments	Number of nodules at		
	20 DAS	35 DAS	50 DAS
S_1B_0	20.48	29.88	20.12
S_1B_1	22.72	33.35	22.45
S_2B_0	22.14	32.64	22.41
S_2B_1	28.68	35.61	25.21
S_3B_0	16.90	26.63	17.55
S_3B_1	20.12	31.63	21.82
SE (±)	0.492	NS	NS
CV (%)	5.39	3.75	6.84

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.5.6 Interaction effect of red chili powder and bleaching powder

Significant interaction effect between the red chili powder and bleaching powder was observed only at 20 DAS, but at 35 and 50 DAS,non-significant effect of total number of nodules produced plant^{-1} was recorded (Table 19 andappendix VII). At all sampling dates, the highest number of nodules was produced from the P_1B_1 and the lowest number of nodule was produced in P_0B_0.

Table 19. Interaction effect of seed size and red chili powder on nodules plant^{-1}of mungbean

Treatments	Number of nodules plant^{-1}at		
	20 DAS	35 DAS	50 DAS
P_0B_0	17.90	27.31	18.16
P_0B_1	19.52	30.36	20.79
P_1B_0	21.78	32.13	21.88
P_1B_1	28.16	36.70	25.52
SE (±)	0.402	NS	NS
CV (%)	5.39	3.75	6.84

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.5.7 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed size, red chili powder and bleaching powder showed the range of significant variation except during 30 and 45 DAS (Table 20 and appendix VII). Larger seed, red chili powder and bleaching powder combination produced the highest number of nodules plant^{-1} at all sampling dates compared than that of others interactions.

Table 20.Interaction effect of seed size, red chili powder and bleaching powder on number of nodules plant^{-1}of mungbean

Treatments	Number of nodules plant^{-1}at		
	20 DAS	35 DAS	50 DAS
$S_1P_0B_0$	18.57	27.97	18.67
$S_1P_0B_1$	19.47	30.00	19.87
$S_1P_1B_0$	22.40	31.80	21.57
$S_1P_1B_1$	25.97	36.70	25.03
$S_2P_0B_0$	20.44	30.89	20.49
$S_2P_0B_1$	22.43	32.80	23.28
$S_2P_1B_0$	23.83	34.40	34.32
$S_2P_1B_1$	34.93	38.41	27.13
$S_3P_0B_0$	14.70	23.07	15.33
$S_3P_0B_1$	16.67	28.28	19.23
$S_3P_1B_0$	19.10	30.20	19.77
$S_3P_1B_1$	23.57	34.98	24.41
SE (±)	0.696	NS	NS
CV (%)	5.39	3.75	6.84

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.6 Dry weight of nodules

4.1.6.1 Effect of seed size

The dry weight of nodule plant^{-1} had significant effect for different seed sizes at all sampling dates (Figure 11 andappendix VIII).The treatment S_2 produced the maximum dry weight of nodules (0.053, 0.125 and 0.090 mg plant^{-1} at 20, 35 DAS and at harvest, respectively). Data also showed that, an increasing trend of nodules dry weight up to 50 DAS and then showed a decreasing trend of nodules weight.

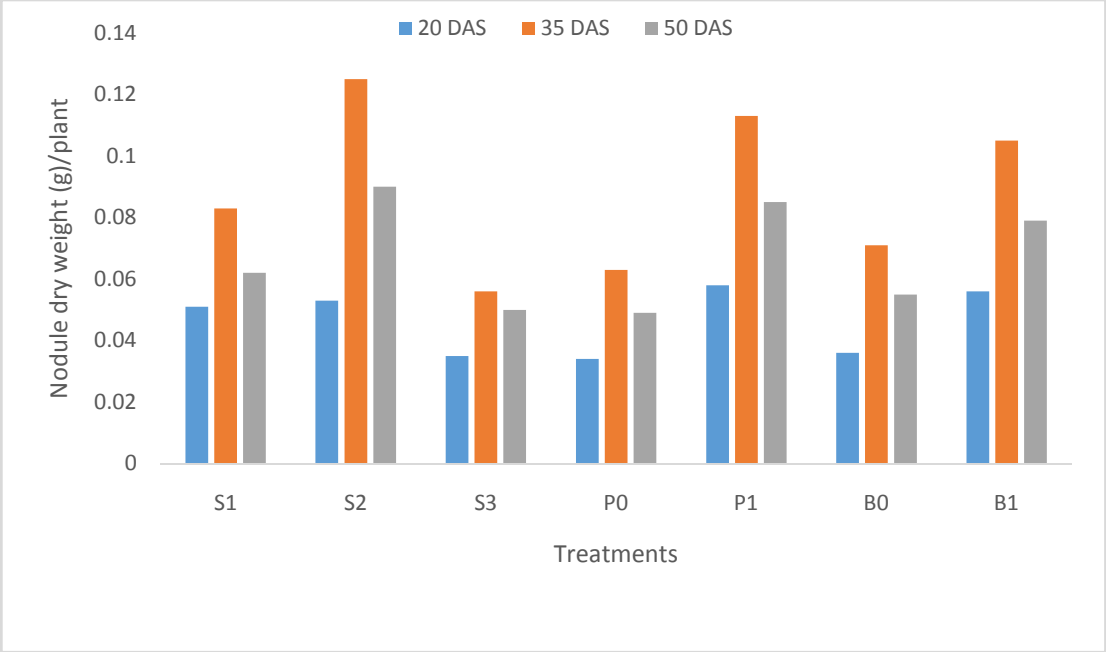
4.1.6.2 Effect of red chili powder

Red chili powder treated seed had significant effect of dry weight of nodules plant^{-1} recorded at 20, 35 and 50 DAS (Figure 7 and appendix VIII). The

maximum dry weight of nodules (0.058, 0.113 and 0.085 mg plant^{-1}) was produced by P_1at all sampling dates compared to control.

4.1.6.3 Effect of bleaching powder

Nodules dry weight of mungbean increased as the age of the plants was increased up to the harvest. From the present study, significant variation was observed in terms of nodules dry weight at entire growth stages for bleaching powder treated seeds (Figure 7 and appendix VIII).



DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 6. Effect of seed size, red chili powder and bleaching powder on nodule dry weight of mungbean

4.1.6.4 Interaction effect of seed size and red chili powder

The interaction effect of seed size and red chili powder was significantly influenced on at 20 DAS (Table 21 and appendixVIII). The highest nodules dry weight was recorded from treatment S_2P_1 at all growth stages.

Table 21. Interaction effect of seed size and red chili powder on nodules dry weight of mungbean

Treatments	Nodules dry weight (mg) plant^{-1}at		
	20 DAS	35 DAS	50 DAS
S_1P_0	0.037	0.058	0.038
S_1P_1	0.065	0.107	0.085
S_2P_0	0.037	0.095	0.077
S_2P_1	0.068	0.155	0.103
S_3P_0	0.030	0.035	0.033
S_3P_1	0.040	0.077	0.067
SE (±)	0.004	NS	NS
CV (%)	18.84	15.70	23.51

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.6.5 Interaction effect of red seed size and bleaching powder

There had no significant effect of red chili powder and bleaching powder interaction on nodules dry weight of mungbean (Table 22 and appendix VIII). But the maximum nodules dry weight was recorded from S_2B_1.

Table 22. Interaction effect of seed size and red chili powder on nodules dry weight (mg) of mungbean

Treatments	Nodules dry weight (mg) plant^{-1}at		
	20 DAS	35 DAS	50 DAS
S_1B_0	0.040	0.063	0.043
S_1B_1	0.062	0.102	0.080
S_2B_0	0.038	0.105	0.082
S_2B_1	0.067	0.145	0.098
S_3B_0	0.030	0.043	0.040
S_3B_1	0.040	0.068	0.060
SE (±)	NS	NS	NS
CV (%)	18.84	15.70	23.51

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.6.6 Interaction effect of red chili powder and bleaching powder

There had a significant effect of red chili powder and bleaching powder interaction (S_2B_1) on nodules dry weight of mungbean at all sampling dates except at 50 DAS (Table 23 and appendix VIII).

Table 23.Interaction effect of red chili powder and bleaching powder on nodules dry weight (mg) of mungbean

Treatments	Nodules dry weight (mg) plant^{-1}at		
	20 DAS	35 DAS	50 DAS
Red Chili Powder × Bleaching Powder (P × B)			
P_0B_0	0.030	0.052	0.038
P_0B_1	0.039	0.073	0.061
P_1B_0	0.042	0.089	0.072
P_1B_1	0.073	0.137	0.098
SE (±)	0.003	0.003	NS
CV	18.84%	15.70%	23.51%

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.1.6.5 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed size, red chili powder and bleaching powder showed the range of significant variation of nodules dry weight plant^{-1}only at 35 DAS (Table 24 and appendix VIII). Larger seed, red chili powder and bleaching powder combination produced the highest nodules dry weight at all sampling dates compared than that of others interactions.

Table 24. Interaction effect of seed size, red chili powder and bleaching powder on nodules dry weight of mungbean

Treatments	Nodules dry weight (mg) plant^{-1} at		
	20 DAS	35 DAS	50 DAS
$S_1P_0B_0$	0.030	0.037	0.017
$S_1P_0B_1$	0.043	0.080	0.060
$S_1P_1B_0$	0.050	0.090	0.070
$S_1P_1B_1$	0.080	0.123	0.100
$S_2P_0B_0$	0.030	0.090	0.070
$S_2P_0B_1$	0.043	0.100	0.083
$S_2P_1B_0$	0.047	0.120	0.093
$S_2P_1B_1$	0.090	0.190	0.113
$S_3P_0B_0$	0.030	0.030	0.027
$S_3P_0B_1$	0.030	0.040	0.040
$S_3P_1B_0$	0.030	0.057	0.053
$S_3P_1B_1$	0.020	0.097	0.080
SE (±)	NS	0.008	NS
CV (%)	18.84	15.70	23.51

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2 Yield and others crop characters

4.2.1 Number of branches plant^{-1}

4.2.1.1 Effect of seed size

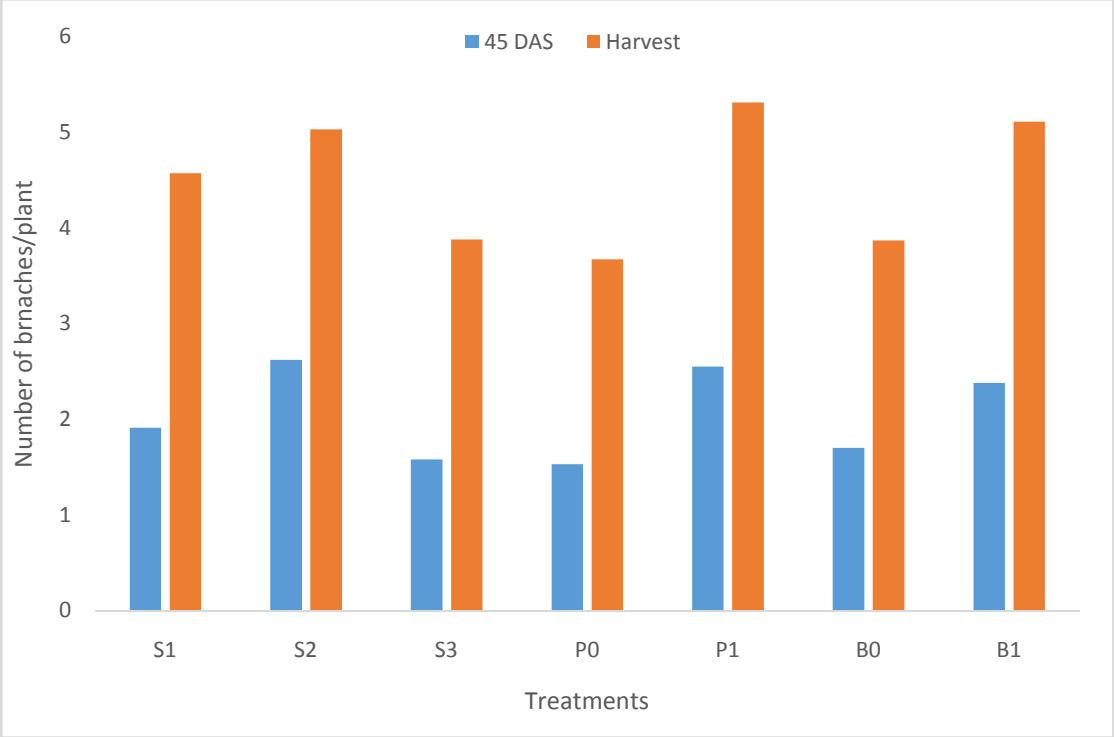
Number of branches plant^{-1} of mungbean showed statistically significant variations at 45 DAS and at harvest for different seed sizes (Figure 7 and appendix IX). From the experiment it was observed that largerseed size helped to produce highest number of branches plant^{-1} of mungbean. Probably seed size helped to increase the vegetative growth in mungbean.

4.2.1.2 Effect of red chili powder

Number of branches plant^{-1} showed significant variation due to different levels of red chili powder application in storage condition (Figure 7 and appendix IX). The data revealed that P_1 produced the highest number of branches plant^{-1} and control plant produced the lowest number of branches plant^{-1} at all sampling dates. The possible reason behind the finding might be that red chili powder helped to promote the vegetative growth of mungbean.

4.2.1.3 Effect of bleaching powder

Mean number of branch showed a wide range of variations where highest number of branch plant^{-1}recorded from bleaching powder treated seeds than control (Figure 7 and appendix IX). This might be due to calcium was responsible to produced highest number of branches.



DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 7. Effect of seed size, red chili powder and bleaching powder on the number of branches plant^{-1} of mungbean

4.2.1.4 Interaction effect of seed size and red chili powder

The interaction effect of seed size and red chili (S_2P_1) had produced the highest number of branches at all growth stages and at harvest (Table 25and appendix IX). Also, there had no significant effect of this interaction, but only at harvest it showed significant effect.

Table 25. Interaction effect of seed size and red chili powder on number branches plant^{-1} of mungbean

Treatments	Number of branches plant^{-1}at	
	45 DAS	Harvest
S_1P_0	1.40	3.68
S_1P_1	2.42	5.45
S_2P_0	2.12	3.97
S_2P_1	3.12	6.08
S_3P_0	1.07	3.37
S_3P_1	2.10	4.40
SE (±)	NS	NS
CV (%)	72.03	16.73

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.1.5 Interaction effect of seed size and bleaching powder

There had no significant effect of seed size and bleaching powder interaction on the number of branches plant^{-1} (Table 26 and appendix IX).

Table 26. Interaction effect of seed size and bleaching powder on number branches plant^{-1} of mungbean

Treatments	Number of branches plant^{-1}at	
	45 DAS	Harvest
S_1B_0	1.55	3.93
S_1B_1	2.27	5.20
S_2B_0	2.34	4.37
S_2B_1	2.90	5.68
S_3B_0	1.20	3.30
S_3B_1	1.97	4.47
SE (±)	-	-
CV	72.03%	16.73%

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.1.4 Interaction effect of red chili powder and bleaching powder

Number of branches palnt^{-1} was significantly influenced by the interaction of red chili powderand bleaching powder at different days after sowing (Table 27 and appendix IX). Result showed that maximum number of branches plant^{-1} was obtained from V_2B_2 at 45 DAS and at harvest.

Table 27. Effect of red chili powder and bleaching powder interaction on the number of branches plant^{-1} in mungbean

Treatments	Number of branches plant^{-1}at	
	45 DAS	Harvest
P_0B_0	1.36	3.47
P_0B_1	1.70	3.88
P_1B_0	2.04	4.27
P_1B_1	3.06	6.36
SE (±)	0.104	0.247
CV (%)	72.03	16.73

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.1.5 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed sizered chili powder and bleaching powder of mungbean showed insignificant differences on number of branches palnt^{-1} at all sampling dates (Table 28 and appendix IX). Mean number of branches plant^{-1} varied from different treatment interactions. Though, $S_2P_1B_1$ produced the height number of branches plant^{-1} at all growth stages, there had no significant variation among the treatment interactions.

Table 28. Interaction effect of seed size-red chili powder-bleaching powder on the number of branches plant^{-1} of mungbean

Treatments	Number of branches plant^{-1}at	
	45 DAS	Harvest
$S_1P_0B_0$	1.20	3.33
$S_1P_0B_1$	1.60	4.03
$S_1P_1B_0$	1.90	4.53
$S_1P_1B_1$	2.93	6.37
$S_2P_0B_0$	1.90	3.87
$S_2P_0B_1$	2.33	4.07
$S_2P_1B_0$	2.78	4.87
$S_2P_1B_1$	3.47	7.03
$S_3P_0B_0$	0.97	3.20
$S_3P_0B_1$	1.17	3.53
$S_3P_1B_0$	1.43	3.40
$S_3P_1B_1$	2.77	5.40
SE (±)	NS	NS
CV (%)	72.03	16.73

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.2 Number of pods plant^{-1}

4.2.2.1 Effect of seed size

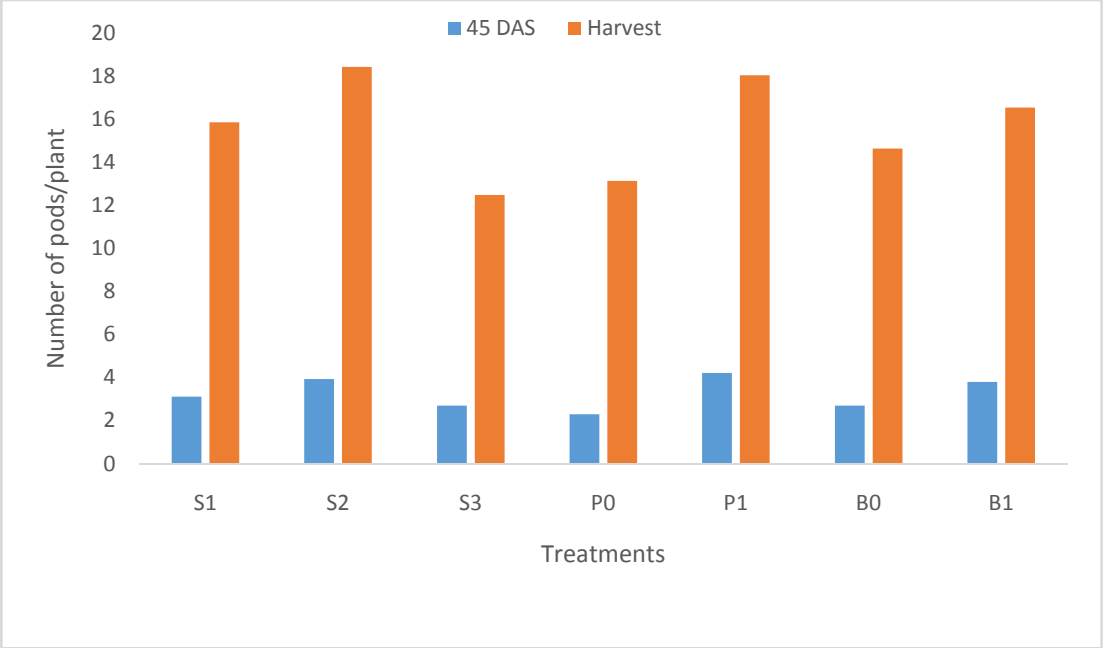
Significant variation was observed for pods plant^{-1} of mungbean from different seed size treatments at 45 DAS and at harvest. Larger seed size treatment produced maximum number of pods plant^{-1}at all sampling dates (Figure 8 and appendix X). In this treatment thesmaller seed produced the lowest number of pods compared to control.

4.2.2.2 Effect of red chili powder

The number of pods plant^{-1} of mungbean was significantly influenced by the application of different levels of red chili powder in storage condition. The treatment P_1 produced the maximum number of pods plant^{-1} andlowest pods was recorded from control treatment (Figure 8 and appendix X). This might be due to that red chili powder had a pronounced effect on stigma receptivity, sticky and making pollen grain fertile and enhanced the pollination.

4.2.2.3 Effect of bleaching powder

Bleaching powder had a significant effect on number of pods plant^{-1}and B_1 produced the highest number of pods plant^{-1} at all sampling dates. On the other hand, P_0 produced lowest number of pods plant^{-1} (Figure 8 and appendix X).



DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 8. Effect of seed size, red chili powder and bleaching powder on the number of pods plant^{-1}of mungbean

4.2.2.4 Interaction effect of seed size and red chili powder

There had no significant impact of interaction effect of seed size and red chili powder on number of pods plant^{-1} at 45 DAS but found the significant effect at harvest (Table 25and appendix X).

Table 29. Interaction effect of seed size and red chili powder on number of pods plant^{-1} of mungbean

Treatments	Number of pods plant^{-1}at	
	45 DAS	Harvest
S_1P_0	2.23	14.32
S_1P_1	3.98	17.37
S_2P_0	2.90	15.83
S_2P_1	4.93	20.97
S_3P_0	1.70	9.20
S_3P_1	3.68	15.72
SE (±)	NS	0.414
CV (%)	70.48	6.08

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.2.5 Interaction effect of seed size and bleaching powder

Interaction effect of seed size and bleaching powder showed significant effect at 45 DAS but there had no significant effect during harvest (Table 30 and appendix X). But, the interaction ofS_2B_1produced the maximum number of pods plant^{-1} at all sampling dates.

Table 30. Interaction effect of seed size and bleaching powder on number of pods plant^{-1} of mungbean

Treatments	Number of pods plant^{-1}at	
	45 DAS	Harvest
S_1B_0	2.78	15.00
S_1B_1	3.43	16.67
S_2B_0	3.31	17.52
S_2B_1	4.52	19.28
S_3B_0	1.97	11.33
S_3B_1	3.42	13.59
SE (±)	0.159	NS
CV (%)	70.48	6.08

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.2.6Interaction effect of red chili powder bleaching powder

Interaction effect of red chili powder and bleaching powderon the number of pods plant^{-1} showed a wide range of variations. The treatment P_1B_1produced highest number of pods plant^{-1}compared to others combination (Table 31 and appendix X).

Table 31. Interaction effect of red chili powder bleaching powder on number of pods plant^{-1} of mungbean

Treatments	Number of pods plant^{-1} at	
	45 DAS	Harvest
P_0B_0	2.03	12.64
P_0B_1	2.52	13.59
P_1B_0	3.34	16.59
P_1B_1	5.06	19.45
SE (±)	0.130	0.338
CV (%)	70.48	6.08

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.2.7 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed size, red chili powder and bleaching powderhad a non-significant influenced on number of pods plant^{-1} of mungbean at all sampling dates. Data revealed that the $S_2P_1B_1$ treatment produced the highest number of pods plant^{-1}compared to others treatment combinations (Table 32 and appendix X).

Table 32. Interaction effect of light-boron-variety on number of pods plant^{-1} of mungbean

Treatments	Number of pods plant^{-1}at	
	45 DAS	Harvest
$S_1P_0B_0$	2.07	13.97
$S_1P_0B_1$	2.40	14.67
$S_1P_1B_0$	3.50	16.03
$S_1P_1B_1$	4.47	18.71
$S_2P_0B_0$	2.60	15.33
$S_2P_0B_1$	3.20	16.33
$S_2P_1B_0$	4.01	19.70
$S_2P_1B_1$	5.84	22.23
$S_3P_0B_0$	1.43	8.63
$S_3P_0B_1$	1.97	9.77
$S_3P_1B_0$	2.50	14.03
$S_3P_1B_1$	4.87	17.41
SE (±)	NS	NS
CV (%)	70.48	6.08

DAS= Days after sowing, S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.3 Pod length

4.2.3.1 Effect of seed size

Pod lengthincreased gradually with the increase in plant age and seed size had the significant result on pod length at all sampling dates (Figure 10 and appendix XI). Larger seed size produced the highest pod lengthcompared to others treatment. It might be due to seed size helped to increase pod length.

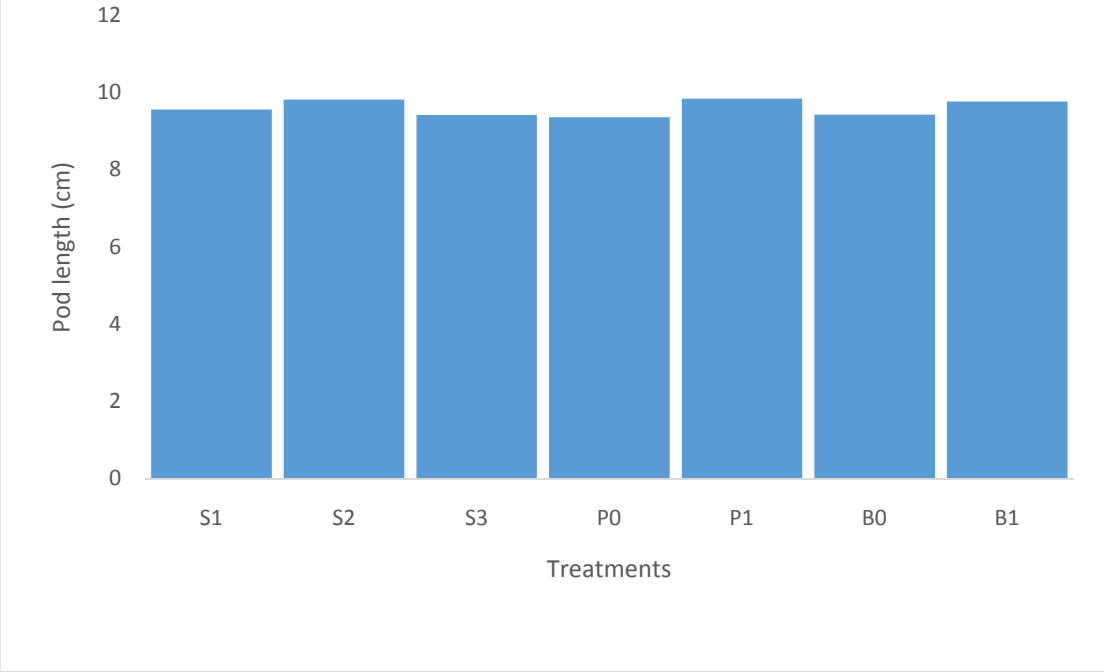
4.2.3.2 Effect of red chili powder

Pod length varied significantly due to influence of different levels of red chili powder application in storage condition (Figure 9and appendix XI). It was noticed that the highest pod length obtained from P_1 and lowest was observed

from control. This might be due to red chili powder had a special importance in fruit formation of legumes crops.

4.2.3.3 Effect of bleaching powder

Pod length significantly varied from bleaching powderapplication in storage. In the present study, data showed that bleaching powder treated seed produced the maximum pod lengthcompared to control (Figure 9 and appendix XI). This might be due to calcium helped to produce highest pod length.The result was as per with the finding of Kumar et al. (2010) and Pathak (2010).



S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 9. Effect of seed size, red chili powder and bleaching powder on the pod length of mungbean

4.2.3.4 Interaction effect of seed size and red chili powder

The interaction effect of seed size and red chili powder was not significantly influenced on pod length of mungbean (Table 33and appendix XI). The highest pod length was recorded from the treatment S_2P_1.

Table 33. Interaction effect of seed size and red chili powder on pod length (cm) of mungbean

Treatments	Pod length (cm)
S_1P_0	9.33
S_1P_1	9.78
S_2P_0	9.53
S_2P_1	10.10
S_3P_0	9.20
S_3P_1	9.63
SE (±)	NS
CV (%)	3.53

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.3.5 Interaction effect of seed size and bleaching powder

There had no significant effect of seed size and bleaching powder interaction on pod length of mungbean (Table 34 and appendix XI). But the maximumpod length was recorded from S_2B_1.

Table 34. Interaction effect of seed size and bleaching powder on pod length (cm) of mungbean

Treatments	Pod length (cm)
S_1B_0	9.40
S_1B_1	9.72
S_2B_0	9.59
S_2B_1	10.04
S_3B_0	9.28
S_3B_1	9.55
SE (±)	NS
CV (%)	3.53

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.3.6 Effect of red chili powder and bleaching powder interaction

Pod length was not significantly influenced by the interaction effect of bleaching powder and red chili powderin the storage condition (Table 35 and appendix XI). Result showed that the maximum pod length was produced from P_1B_1 treatment.

Table 35. Effect of red chili powder-bleaching powder interaction on the pod length of mungbean

Treatments	Pod length (cm)
P_0B_0	9.25
P_0B_1	9.46
P_1B_0	9.60
P_1B_1	10.08
SE (±)	NS
CV (%)	3.53

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.3.7 Interaction effect of seed size, red chili powder and bleaching powder

Interaction of seed size, red chili powder and bleachingpowder on pod length of mungbean showed an insignificant result (Table 36 and appendix XI). Though, the result revealed that $S_2P_1B_1$ treatment produced the maximumpod length over other interactions but there had no significant variations among the different interactions.

Table 36. Interaction effect of seed size-red chili powder-bleaching powder on the pod length plant^{-1} of mungbean

Treatmentss	Pod length (cm)
$S_1P_0B_0$	9.30
$S_1P_0B_1$	9.37
$S_1P_1B_0$	9.50
$S_1P_1B_1$	10.07
$S_2P_0B_0$	9.43
$S_2P_0B_1$	9.63
$S_2P_1B_0$	9.75
$S_2P_1B_1$	10.45
$S_3P_0B_0$	9.02
$S_3P_0B_1$	9.38
$S_3P_1B_0$	9.55
$S_3P_1B_1$	9.72
SE (±)	NS
CV (%)	3.53

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.4 Number of seedspod^{-1}

4.2.4.1 Effect of seed size

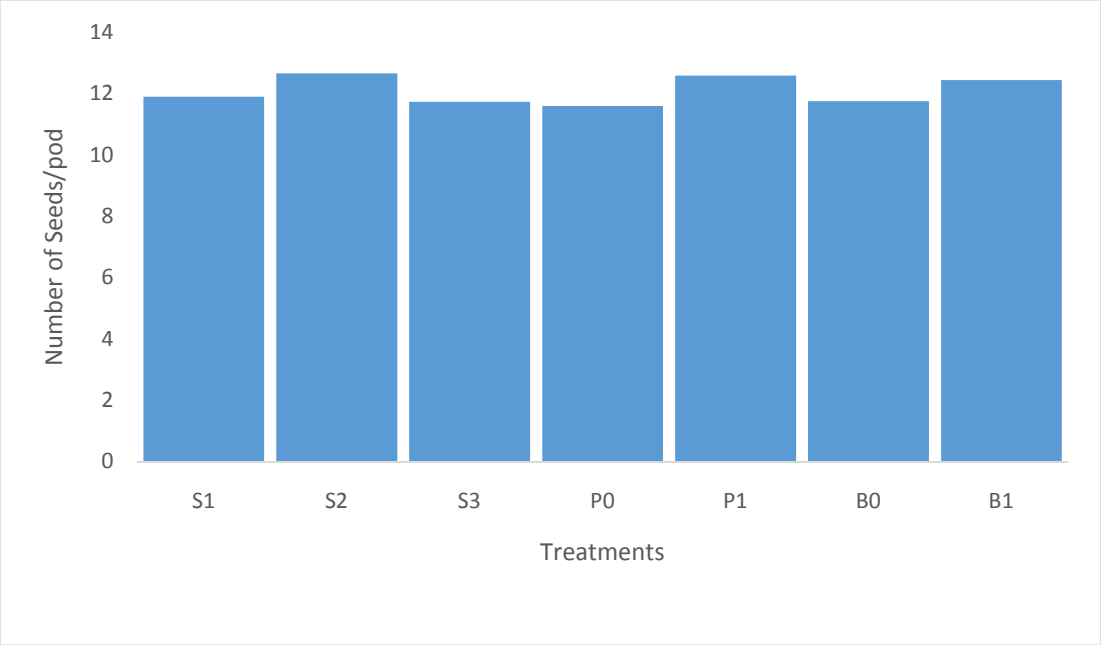
Seed size had a significant influenced on number of seeds pod^{-1}of mungbean (Figure 10 and appendix XI). Larger seed size always produced the highest number of seeds pod^{-1}over others treatment. Kabir(2000)stated thatseedsize of legume had significanteffecton number ofseedperpod.

4.2.4.2 Effect of red chili powder

Number of seeds pod^{-1}showed significant variation with the application of different doses of red chili powderin storage (Figure 10 and appendix XI). Red chili powdertreated seeds produced the highest number of seeds pod^{-1}of mungbean.

4.2.4.3 Effect of bleaching powder

Number of seeds pod^{-1} of mungbean varied significantly inbleaching powdertreated seeds in storage (Figure 10 and appendix XI). The B_1produced the highest number of seeds pod^{-1}compared to control.



S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 10. Effect of seed size, red chili powder and bleaching powder on the number of seeds pod^{-1} of mungbean

4.2.4.4 Interaction effect of seed size and red chili powder

The interaction effect seed size and red chili (S_2P_1) had produced the highest number of seeds compared to others treatments (Table 37 and appendixXI). But, there had no significant effect of this interaction, but only at harvest it showed significant effect.

Table 37. Interaction effect of seed size and red chili powder on number of seeds pod^{-1} of mungbean

Treatments	Seeds pod^{-1} (No.)
S_1P_0	11.50
S_1P_1	12.31
S_2P_0	11.97
S_2P_1	13.36
S_3P_0	11.33
S_3P_1	12.13
SE (±)	NS
CV (%)	1.75

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.4.5 Interaction effect of seed size and bleaching powder

Interaction effect of seed size and bleaching powder showed non-significant effect on seeds pod^{-1}of mungbean (Table 38 and appendixXI). Data showed that S_2B_1 produced the maximum number of seeds pod^{-1} of mungbean.

Table 38. Interaction effect of seed size and red chili powder on number of seeds pod^{-1} of mungbean

Treatments	Seeds pod^{-1}(No.)
S_1B_0	11.63
S_1B_1	12.18
S_2B_0	12.17
S_2B_1	13.16
S_3B_0	11.48
S_3B_1	11.98
SE (±)	NS
CV (%)	1.75

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.4.6Interaction effect of red chili powder and bleaching powder

Interaction effect of red chili powder and bleaching powder varied significantly in terms of number of seeds pod^{-1}(Table 39 and appendix XI). It was observed that the P_1B_1 produced maximum number of seeds pod^{-1}compared to others interactions.

Table 39. Effect of red chili powder and bleaching powder interaction on the number of seeds pod^{-1} of mungbean

Treatments	Seeds pod^{-1} (No.)
P_0B_0	11.46
P_0B_1	11.74
P_1B_0	12.05
P_1B_1	13.14
SE (±)	0.149
CV (%)	1.75

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.4.7 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed size, red chili powder and bleaching powder had an insignificant influenced on number of seeds $pod^{-1}$of mungbean (Table 40 and appendix XI). The $S_2P_1B_1$ treatment produced the highest number of seeds pod^{-1} compared others combinations.

Table 40. Interaction effect of seed size, red chili powder and bleaching powder on the number of seeds pod^{-1} of mungbean

Treatments	Seeds pod^{-1} (No.)
$S_1P_0B_0$	11.42
$S_1P_0B_1$	11.58
$S_1P_1B_0$	11.83
$S_1P_1B_1$	12.78
$S_2P_0B_0$	11.82
$S_2P_0B_1$	12.12
$S_2P_1B_0$	12.52
$S_2P_1B_1$	14.20
$S_3P_0B_0$	11.15
$S_3P_0B_1$	11.52
$S_3P_1B_0$	11.80
$S_3P_1B_1$	12.45
SE (±)	NS
CV (%)	1.75

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.5 The 1000 seeds weight

4.2.5.1 Effect of seed size

The 1000 seeds weight of mungbean had a significant influenced due toseed size. It was noticed that larger seed size produced the highest 1000 seeds weight over the control treatment (Figure 11 and appendix XI).

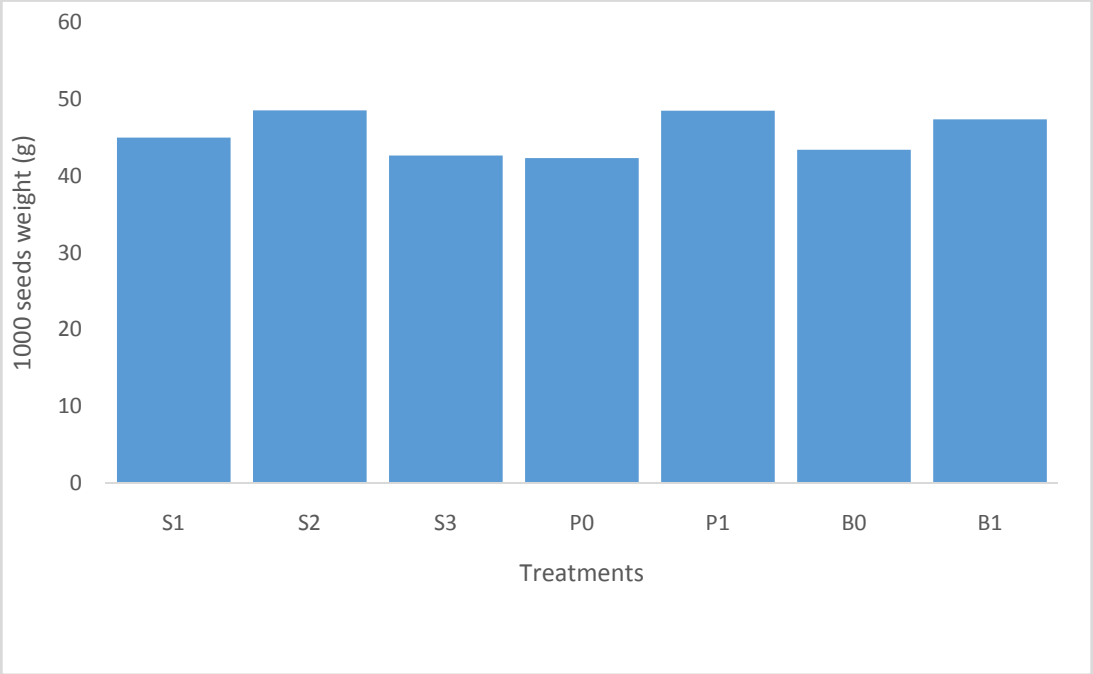
4.2.5.2 Effect of red chili powder

Thousand seed weight of mungbean showed significant variations with the application of different levels of red chili powder in storage. Data revealed that thered chili powdertreated seeds produced the highest 1000 seeds weight over the control treatment (Figure 11 and appendix XI). This might be due to that

application of red chili powder helped to increase the 1000 seeds weight of mungbean.

4.2.5.3 Effect of bleaching powder

Bleaching powder had a significant effect on 1000 seeds weight of mungbean. Bleaching powdertreated seeds produced the highest 1000 seeds weight compared to control (Figure 11 and appendix XI).



S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 11. Effect of seed size, red chili powder and bleaching powder on 1000 seeds weight of mungbean

4.2.5.4 Interaction effect of seed size and red chili powder

The interaction effect of seed size and red chili powder showed significant effect and (S_2P_1) produced the highest 1000 seeds weight of mungbean (Table 41 appendix XI).

Table 41. Interaction effect of seed size and red chili powder on 1000 seeds weight of mungbean

Treatments	1000 seeds weight (g)
S_1P_0	42.34
S_1P_1	47.67
S_2P_0	46.02
S_2P_1	51.01
S_3P_0	38.56
S_3P_1	46.76
SE (±)	1.316
CV (%)	0.74

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.5.5 Interaction effect of seed size and bleaching powder

Interaction effect of seed size and bleaching powder showed non-significant effect on 1000 seeds weight of mungbean (Table 42and appendixXI). TreatmentS_2B_1 produced the highest 1000 seeds weight compared to others interaction.

Table 42. Interaction effect of seed size and bleaching powder on 1000 seed weightof mungbean

Treatments	1000 seeds weight (g)
S_1B_0	43.03
S_1B_1	46.99
S_2B_0	46.90

S_2B_1	501.28
S_3B_0	40.29
S_3B_1	45.03
SE (±)	1.316
CV (%)	0.74

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.5.6Interaction effect of red chili powder and bleaching powder

Interaction effect of bleaching powder and red chili powder had a significant influenced on 1000 seeds weight of mungbean. The P_1B_1 interaction produced the highest 1000 seeds weight (Table 43 and appendix XI). TheP_0B_0 treatment produced the lowest 1000 seeds weight.

Table 43. Effect of red chili powder and bleaching powder interaction on 1000 seed weightof mungbean

Treatment	1000 seeds weight (g)
P_0B_0	41.40
P_0B_1	43.22
P_1B_0	45.42
P_1B_1	51.54
SE (±)	1.075
CV (%)	0.74

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.5.7 Interaction effect of seed size,red chili powder and bleaching powder

Interaction effect of seed size,red chili powder and bleaching powder on thousand seed weight of mungbean showed an insignificant variation (Table 44

and appendix XI). Result revealed that the $S_2P_1B_1$ treatment produced highest 1000 seeds weight compared to other interactions.

Table 44. Interaction effect of seed size, red chili powder and bleaching powder interaction on 1000 seeds weight of mungbean

Treatment	1000 seeds weight (g)
$S_1P_0B_0$	42.14
$S_1P_0B_1$	42.54
$S_1P_1B_0$	43.91
$S_1P_1B_1$	51.43
$S_2P_0B_0$	43.81
$S_2P_0B_1$	48.24
$S_2P_1B_0$	50.00
$S_2P_1B_1$	52.02
$S_3P_0B_0$	38.24
$S_3P_0B_1$	38.89
$S_3P_1B_0$	42.34
$S_3P_1B_1$	51.17
SE (±)	1.861
CV (%)	0.74

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.9 Pod yield

4.2.9.1 Effect of seed size

Total pod yieldsof mungbean showed statistically significant variations with the seed size treatment. From the experiment it was observed that larger seed size produced the highest pod yield than to composite and smaller seed (Figure

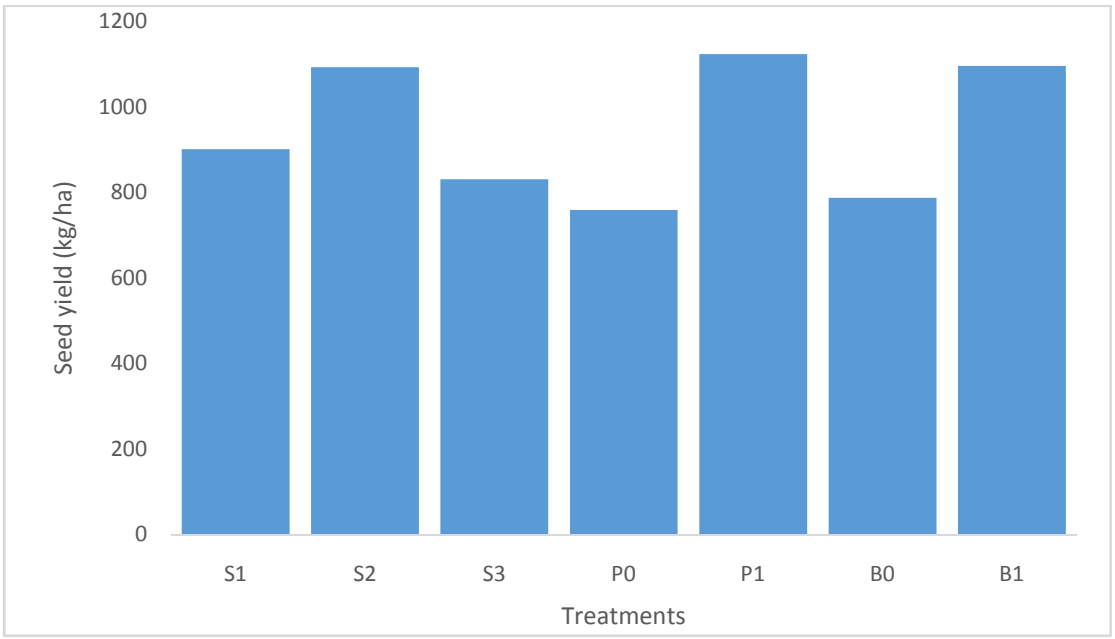
12 and appendix XII). This might be due to that extended photoperiod larger seed had more stored food to produce the healthier plant and facilitated the reproductive development of mungbean.

4.2.9.2 Effect of red chili powder

Pod yieldshowed significant variations due to different levels of red chili powder application. The data revealed that P_1 produced the highest total pods yield and control plant produced the lowest pods yield (Figure 12 and appendix XII). This might be that P helped to increase the reproductive development of mungbean and finally increased the pods yield.

4.2.9.3 Effect of bleaching powder

Pod yieldhad significant variations for bleaching powder treated seeds. Treatment B_1 produced the highest pod yield compared to control (Figure 12 and appendix XII). This might be due to that calcium had pronounced effect of producing higher yield of mungbean.



S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 12. Effect of seed size, red chili powder and bleaching powder on pod yield mungbean

4.2.9.4 Interaction effect of seed size and red chili powder

The interaction effect seed size and red chili (S_2P_1) had produced significantly the highest pod yield compare to other combinations (Table 45 appendix XII).

Table 45. Interaction effect of seed size and red chili powder pod yieldof mungbean

Treatments	Pods yield (kg ha^{-1})
S_1P_0	1227.76
S_1P_1	1734.45
S_2P_0	1379.17
S_2P_1	2191.18
S_3P_0	1153.23
S_3P_1	1554.35
SE (±)	43.248
CV (%)	6.93

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.9.5 Interaction effect of seed size and bleaching powder

There had a positively significant effect of seed size and bleaching powder interaction on the pod yield (Table 46 and appendix XII). The treatment S_2B_1 produced the highest pod yield compared to others treatment combination.

Table 46. Interaction effect of seed size and bleaching powder pod yield of mungbean

Treatments	Pods yield (kg ha^{-1})
S_1B_0	1388.46
S_1B_1	1573.75
S_2B_0	1436.27
S_2B_1	2134.08

S_3B_0	1192.98
S_3B_1	1514.60
SE (±)	43.248
CV (%)	6.93

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.9.6Interaction effect of red chili powder and bleaching powder

Pod yield was significantly influenced by the interaction of red chili powder doses and bleaching powder. Result showed that, the highest pod yield was obtained from P_1B_1compared to other interactions (Table 47 and appendix XII).

Table 47. Effect of red chili powder and bleaching powder interaction on pod yield of mungbean

Treatments	Pods yield (kg ha^{-1})
P_0B_0	1145.46
P_0B_1	1361.31
P_1B_0	1533.01
P_1B_1	2120.31
SE (±)	35.312
CV (%)	6.93

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.9.7 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed size, red chili powder and bleaching powder of mungbean showed significant differences on the pod yield. Total pod yield

varied among the treatment combinations (Table 48 and appendix XII). The data revealed that the $S_2P_1B_1$produced the highest pod yield compared to other treatment interactions.

Table 48. Interaction effect of seed size, red chili powder and bleaching powder on pod yieldof mungbean

Treatments	Pods yield (kg ha^{-1})
$S_1P_0B_0$	1153.22
$S_1P_0B_1$	1302.30
$S_1P_1B_0$	1623.70
$S_1P_1B_1$	1845.20
$S_2P_0B_0$	1267.60
$S_2P_0B_1$	1490.73
$S_2P_1B_0$	1604.93
$S_2P_1B_1$	2777.43
$S_3P_0B_0$	1015.57
$S_3P_0B_1$	1290.90
$S_3P_1B_0$	1370.40
$S_3P_1B_1$	1738.30
SE (±)	61.162
CV (%)	6.93

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10 Seed yield

4.2.10.1 Effect of seed size

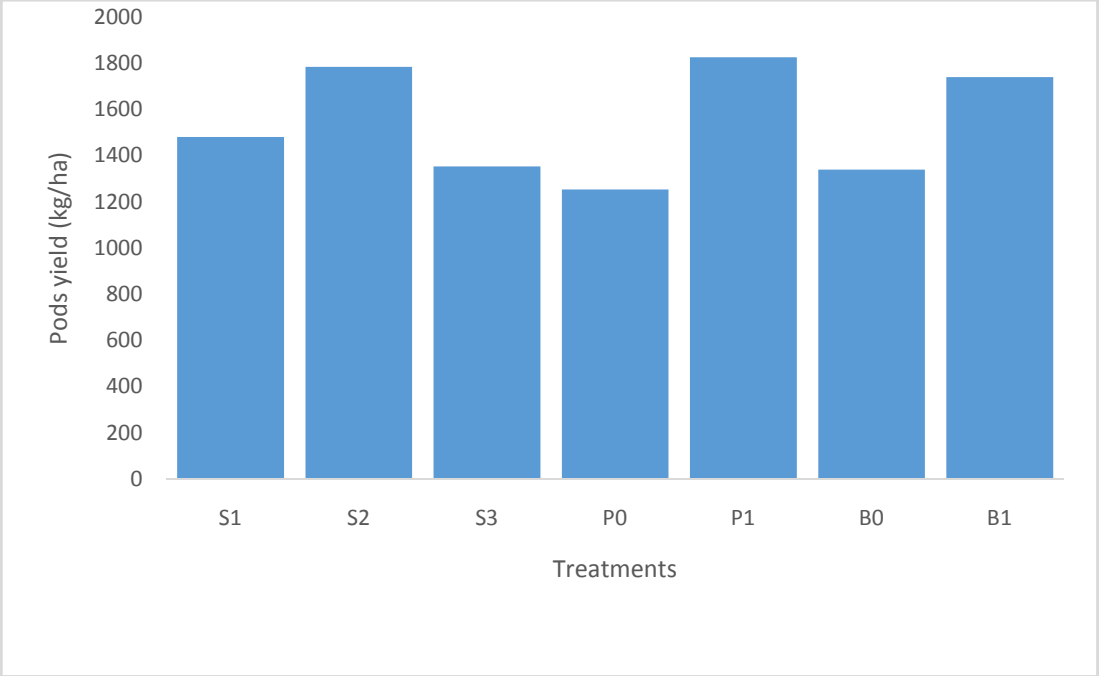
Seed yield showed significant variations due to differentseed size. The highest seed yield was obtained from the larger seed size over the seed size treatment (Figure 13 and appendix XII).

4.2.10.2 Effect of red chili powder

Red chili powder applied in storage condition facilitated the highest seed yield than the control (Figure 13 and appendix XII). This might be due to that red chili powder helped to increased seed yield of mungbean.

4.2.10.3 Effect of bleaching powder

Bleaching powder treated seed produced the highest amount of seed yield while control showed the lowest (Figure 13 and appendix XII).



S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 13. Effect of seed size, red chili powder and bleaching powder on seed yieldof mungbean

4.2.10.4 Interaction effect of seed size and red chili powder

The interaction effect of seed size and red chili (S_2P_1) had produced significantly the highest seed yield compared to other combinations (Table 49 appendix XII).

Table 49.Interaction effect of seed size and red chili powder on seed yield of mungbean

Treatments	Seeds yield (kg ha^{-1})
S_1P_0	760.83
S_1P_1	1041.33
S_2P_0	790.72
S_2P_1	1394.99
S_3P_0	726.21
S_3P_1	935.01
SE (±)	43.458
CV (%)	0.56

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10.5 Interaction effect of seed size and bleaching powder

There had a positively significant effect of seed size and bleaching powder interaction on the seed yield of mungbean (Table 50 and appendix XII). The treatment S_2B_1 produced the highest seed yield compared to others treatment combination.

Table 50. Interaction effect of seed size and bleaching powder on seed yield of mungbean

Treatments	Seeds yield (kgha^{-1})
S_1B_0	855.78
S_1B_1	946.39
S_2B_0	782.18

S_2B_1	1403.53
S_3B_0	724.23
S_3B_1	936.98
SE (±)	43.458
CV (%)	0.56

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10.6 Effect of red chili powder and bleaching powder interaction

Seed yield showed significant variations with the application of different doses of red chili powderand bleaching powder. Data revealed that P_1B_1 produced the highest seed yield over other interactions (Table 51 and appendix XII).

Table 51. Effect of red chili powder and bleaching powder interaction on seed yield of mungbean

Treatments	Seeds yield (kg/ha)
Red Chili Powder × Bleaching Powder (P × B)	
P_0B_0	685.77
P_0B_1	832.74
P_1B_0	889.03
P_1B_1	1358.53
SE (±)	35.483
CV (%)	0.56

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10.5 Interaction effect of seed size, red chili powder and bleaching powder

Interaction between seed size,red chili powder and bleaching powder had a significantly positive effect on seed yield and data showed that $S_2P_1B_1$ gave the best result compared to other combinations (Table 52 and Appendix XII).

Table 52. Interaction effect of seed size, red chili powder and bleaching powder on seed yield of mungbean

Treatment	Seeds yield (kg ha^{-1})
$S_1P_0B_0$	714.95
$S_1P_0B_1$	806.72
$S_1P_1B_0$	996.60
$S_1P_1B_1$	1086.07
$S_2P_0B_0$	707.05
$S_2P_0B_1$	874.40
$S_2P_1B_0$	857.31
$S_2P_1B_1$	1932.67
$S_3P_0B_0$	635.30
$S_3P_0B_1$	817.12
$S_3P_1B_0$	813.17
$S_3P_1B_1$	1056.85
SE (±)	61.458
CV (%)	0.56

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10Harvest Index

4.2.10.1 Effect of seed size

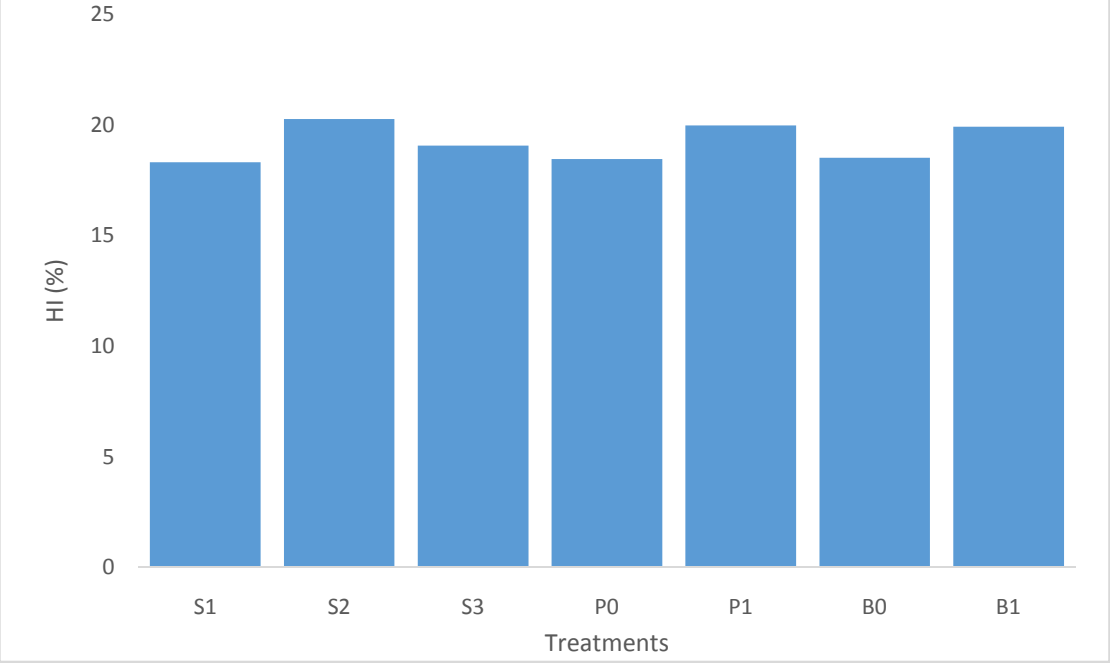
Seed size treatment had a significant effect on harvest index of mungbean. The larger seed produced the highest harvest index while lowest was found in control treatment (Figure 14 and appendix XII).

4.2.10.2 Effect of red chili powder

Harvest index showed significant variations with the application of different levels of red chili powder on mungbean. Data revealed that the application of P_1 produced the higher harvest index and control treatment produced the lowest harvest index (Figure 14 and appendix XII).

4.2.10.3 Effect of bleaching powder

Bleaching powder had a significant effect on harvest index of mungbean. Treatment B_1 produced the highest harvest index (49.42%) than control (48.82%) (Figure 14 and appendix XII).



S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

Figure 14. Effect of seed size, red chili powder and bleaching powder on harvest index of mungbean

4.2.10.4 Interaction effect of seed size and red chili powder

There had no significant impact of interaction effect of seed size and red chili powder on harvest index of mungbean (Table 53 and appendix XII). But the interaction S_1P_1 produced the highest harvest index.

Table 53. Interaction effect of seed size and red chili powder on harvest index of mungbean

Treatments	HI (%)
S_1P_0	18.14
S_1P_1	18.49
S_2P_0	19.06
S_2P_1	21.51
S_3P_0	18.21
S_3P_1	19.96
SE (±)	NS
CV (%)	8.04

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10.5 Interaction effect of seed size and bleaching powder

Interaction effect of seed size and bleaching powder showed non-significant effect on harvest index of mungbean (Table 54 and appendix XII). In spite of having non-significant impact, the treatment combination S_2B_1 produced the maximum harvest index.

Table 54. Interaction effect of seed size and bleaching powder on harvest index of mungbean

Treatments	HI (%)
S_1B_0	18.36

S_1B_1	18.28
S_2B_0	18.76
S_2B_1	21.81
S_3B_0	18.45
S_3B_1	19.72
SE (±)	NS
CV (%)	8.04

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10.6 Effect of red chili powder and bleaching powder interaction

Interaction effect of red chili powder and bleaching powder had a significant influenced on harvest index of mungbean. The P_1B_1 interaction produced the highest value of harvest indexand P_1B_0 produced the lowest harvest index of mungbean (Table 55 and appendix XII).

Table 55. Interaction effect of red chili powder and bleaching powder on harvest index of mungbean

Treatment	HI (%)
P_0B_0	17.23
P_0B_1	19.71
P_1B_0	19.81
P_1B_1	20.16
SE (±)	0.510
CV (%)	8.04

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

4.2.10.5 Interaction effect of seed size, red chili powder and bleaching powder

Interaction effect of seed size, red chili powder and bleaching powder on harvest index of mungbean showed a wide range of variations (Table 56 and appendix XII). Result revealed that $S_2P_1B_1$ produced the highest value of harvest index and $S_1P_0B_0$produced the lowest value of harvest index.

Table 56 Interaction effect of seed size-red chili powder-bleaching powder on seed harvest index of mungbean

Treatments	HI (%)
$S_1P_0B_0$	17.20
$S_1P_0B_1$	19.08
$S_1P_1B_0$	19.51
$S_1P_1B_1$	17.47
$S_2P_0B_0$	18.16
$S_2P_0B_1$	19.95
$S_2P_1B_0$	19.35
$S_2P_1B_1$	23.66
$S_3P_0B_0$	16.32
$S_3P_0B_1$	20.10
$S_3P_1B_0$	20.57
$S_3P_1B_1$	19.34
SE (±)	0.884
CV (%)	8.04%

S_1 = composite seed, S_2 = large seed, S_3= small seed; P_0=control, P_1= 1g red chili powder per kg seed; B_0= control, B_1= 2g bleaching powder per kg seed. Means were separated by Tukey's test at $P \leq 0.05$.

CHAPTER V
SUMMARY AND CONCLUSION

The present investigation indicated that the application of red chili powder and bleaching powder on different seed sizes in storage had a positive effect on vegetative and reproductive development as well as yield of mungbean.

Plant emergence, plant height (cm), leaves plant^{-1}, plant dry weight (g) pant^{-1}, number of nodules plant^{-1},dry weight of nodules plant^{-1}(mg), number of branches plant^{-1}, number of pods plant^{-1}, pods length (cm), number of seeds pod^{-1}, 1000 seed weight (g), pod yield (kg ha^{-1}), seed yield (kg ha^{-1}) and harvest index showed the best result in larger seeds sizes for individual application of red chili powder and bleaching powder in storage condition. Whereas smaller seeds having no red chili powder and bleaching powder gave the lowest result. Combine effect of S_2P_1, S_2B_1, P_1B_1, $S_2P_1B_1$ gave the highest result in terms of vegetative and reproductive growth as well as yield of mungbean. But the lowest values of the studied parameters were obtained from the S_1P_0, S_1B_0, P_0B_0, $S_1P_0B_0$.

Seed weight was highest values for S_2 (1092.86 kg ha^{-1}) and lowest for S_3 (830.61 kg ha^{-1}). For bleaching powder and red chili powder highest produced from P_1 and B_1(1123.78 kg ha^{-1}, 1095.64 kg ha^{-1} and 759.26 kg ha^{-1}, 787.40 kg ha^{-1}, respectively).

Seed weight was highest values for S_2 (1785.17kg ha^{-1}) and lowest for S_3 (1353.79kg ha^{-1}). For bleaching powder and red chili powder highest produced from P_1 and

B_1(1826.66 kg ha^{-1}, 1740.81 kg ha^{-1} and 1253.37kg ha^{-1}, 1339.24kg ha^{-1}, respectively).

Similarly harvest indexwas highest values for S_2 (20.28%) and lowest for S_1 (18.32%). For bleaching powder and red chili powder highest produced from P_1 and B_1(19.99%, 19.93% and 18.47%, 18.52%, respectively).

Above results revealed that application of red chili powder and bleaching powder in storage condition in larger seeds increasedthe vegetative growth and yield. The highest value of vegetative growth and yield contributing character like the number of pods, pod dry weight, 1000 seed weight, pod yield and seed yield and harvest index, explained that dry matter increased by larger seeds due to the red chili powder and bleaching powder application in storage did transform into the reproductive organs. Furthermore, probably the dry matter produced by the application of red chili powder and bleaching powder contributed to the vegetative growth and was enough to be partitioned into yield components. To have a clear idea, we should continue the study furthermore by increasing the level of red chili powder and bleaching powder in storage. So further study should be carried out to verify the increasing trend of P and B by increasing the red chili powder and bleaching powder levels. Therefore, it can be concluded that the application of red chili powder and bleaching powder had a positive impact on larger seeds size of mungbean.

REFERENCES

Adedire, C. O.andAkinkurolere, R. O. (2005). Bioactivity of four plant extracts on coleopterous pests of stored cereals and grain legumes in Nigeria. *Zool. Res.***26**(3): 243-249.

Amin, A.D.M (1999). Influence of seed size on the performance of mungbean varieties under post rice and upland cropping system. Asian Regional Center-AVRDC [on-line URL: www.arc-avrdc.org/pdf_fiels/Amin(17-N.pdf] accessed on July 13, 2017.

Anonymous. (1988a). Land Resources Appraisal of Bangladesh for Agricultural Development. Report No. 2. Agroecological Regions of Bangladesh, UNDP and FAO. pp. 472-496.

Anonymous. (1988b). The Year Book of Production. FAO, Rome, Italy.

Anonymous. (2004). Annual Internal Review for 2000-2001. Effect of seedling throwing on the grain yield of wart land rice compared to other planting methods. Crop Soil Water Management Program, Agronomy Division, BRRI, Gazipur-1710.

AVRDC. (1998). Mungbean: Proceeding of the second international symposium. S. Shanmungasundaram (ed.) (Asian Vegetable Research and Development Center), Taiwan. pp. 19-28.

BBS (Bangladesh Bureau of Statistics). (2006). Statistical Year Book of Bangladesh. Stat. Div. Minist. Plann. Govt. People's Repub. Bangladesh, Dhaka. p.408.

BBS (Bangladesh Bureau of Statistics). (2008). Statistical Year Book of Bangladesh. Agriculture Wing, Crop Statistics (Major Crops), Stat. Div. Minist. Plann. Govt. People's Repub. Bangladesh, Dhaka.p.2.

Bicer, B.T.(2009). Theeffectofseedsizeonyieldandyieldcomponentsof chickpea and lentil.*Afr.J.Biotechnol.***8**:1482-1487.

Burries, J. S., Wahab, A.H. and Edge, O. T. (1973). Effect of seed size on seedling performance in soybean II: Seedling growth and photosynthesis and field performance. *Crop Sci*. **13**:207-210.

Chiangmai, P.N.,Laosuwan, P. and Waranyuwat. A. (2000). The Effect of Mungbea seed size on germinating ability, bean sprout production and agronomic characters.*Indian J.Agri. Sci*.**10**:31-170.

Christensen, C.M. (1973). Loss of viabiling in storage microflora. *Seed Sci. Technol*. **1**:547-562.

Cox, M. C.,Qualset, C. O. and Raines, D.W. (1985). Genetic variation for nitrogen assimilation and tranlocation in wheat. II. Nitrogen assimilation in relation to grain yield and protein.*Crop Sci*. **25**: 435-440.

FAO (Food and Agriculture Organization). (1999). FAO Production Year Book, Basic Data Unit. Statistical Division, FAO, Rome, Italy.

Gan, Y. T., Miller, P. R. and Mcdonald, C. L. (2003). Response of kabuli chickpea to seed size and planting depth. *Can. J. Plant Sci*.**83**: 39-46.

Gardner, F. P., Pearce, R. B. and Mistechell, R. L. (1985). Physiology of Crop Plants. Iowa State Univ. Press, Powa. p.66.

Haper, J. L. and Beton, R. A. (1966). The behavior of seeds in soil, part 2. The germination of seeds on the surface of water supply substrata. *J. Ecol*. **54**: 151-166

Hojjat, S. S. (2011). Effect of seed size on germination and seedling growth of some lentil genotypes. *Int. J. Agril. Crop Sci*.**3**: 1-5.

Hossain,A. S. M. A., Islam, S. M. A. S., Akhter, K., Akhter, N. and Muqit, A. (2010). Effect of plant extracts, insecticides and cultural practices on growth characters and disease severity of mungbean yellow mosaic. *Int. J. Sustain. Crop Prod*.**5**(2):16-20.

Hossain, A., Sarker, M. A. Z., Hakim, M. A., Islam, M. T. and Ali, M. E. (2013). Effect of lime, magnesium and boron on wheat (*Triticumaestivum* L.) and their residual effects on mungbean (*Vigna radiata* L.). *Int. J. Agric. Res.Innov. Technol*.**1**(1-2): 9-15.

Hussain, M. S., Rahman, M. M., Harun-ur-rashid, M., Farid, A. T. M., Quyyum, M. A., Ahamed, M., Alam, M. S. and Salahuddin, K. M. (2006). Krishi ProjuktiHatboy (Handbook on Agro-tecnology), 4th edition, Bangladesh AriculturalResearh Institute, Gazipur 1701.pp. 123-142.

Islam, M. Z. (2004). Effects of seed size and harvesting method on the yield and seed quality of three varieties of summer mungbean. M. S. Thesis. Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Kabir, M. N. (2000). Effect of seed size and depth of sowing on the seedling emergence, growth and seed yield of soybean. M. S. Thesis. Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Kaul, A.K. (1982). Pulses in Bangladesh. BARC, Farmgate, Dhaka. p.27.

Kaydan, D., Yagmur, M. (2008). Germination, seedling growth and relative water content of shoot in different seed sizes of triticale under osmotic stress of water and NaCl. *African J. Biotech*. **7**: 2862-2868.

Kumar, A., Kumar, D. and Arya, K. P. S. (2010). Effect of calcium and sulphur on the growth and yield of mungbean [*Vigna radiata* (L.) Wilczek]. *Int. J. Plant Sci*.**5**(1): 162-164.

Lone, I. A., Bhat, S. A., Sheikh, S. A. and Suliaman1dar, M. (2014). Effects of dry seed treatment on various quality characters in maize (*Zea mays* L.).*Int. J. Innov. Sci. Eng. Technol*.**1**(4):512-521.

Mut, Z. andAkay, H. (2010). Effect of seed size and drought stress ongermination and seedling growth of naked oat (*Avena sativa* l.). *Bulgarian J. Agril. Sci*.**16**: 459-467.

Pathak, B. (2010). Effect of calcium on peanut (*Arachishypogaea* L.) pod and seed development under field conditions.M.S. Thesis. Dept. Agron., University of Florida.

Patra, S. (2017). Effect of pre-storage seed invigoration treatment in onion (*Allium cepa* L., cv. Agrifound Dark Red) for improved germinability and field performance. *Int. J. Curr. Microbiol. App. Sci*.**6**(6), 478-482.

Pedersen, M.(2006). Effect of seed size on physiological growth and yieldof soybean. *Int. J. Agric. Res. Sci. Technol*.**7**(5):200-206.

Royo, C., Ramdani, A., Moragues, M. and Villegas, D. (2006). Durum wheat under Mediterranean conditions as affected by seed size. *J. Agron. Crop Sci.* **192**: 257-266.

Stougaard, R.N. andXue,Q.(2005).Qualityversusquantity:springwheatseed size and seedingrate effects on*Avenafatua*interference, economic returnsandeconomic thresholds.*WeedRes.* **45**:351-360.

Vishvanath, K.,Kalappa, V. P. and Prasad, S. R. (2006). Standardisation of screen sizes for French bean seed processing. *Seed Res*.**34**: 77-81.

Wan Zainun, N. and Parbery D.G. (1971). Studies on seed- borne fungi of Tropical Pasture Legume species. *Aust. J. Agric. Res*.**28**:821-841.

Yadav, R., Jat, L. K., Yadav, S. N., Singh, R. P. and Yadav, P. K. (2014). Effect of gypsum on growth and yield of groundnut (*Arachishypogaea* L.). *Environ. Ecol*. **33**(2): 676-679.

APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period of August, 2016 to November 2016

Month	Air temperature (^{0}C)		Relative humidity (%)		Rainfall (mm) (total)
	Maximum	Minimum	Maximum	Minimum	
August	32.4	19.2	80.2	46.4	202
September	28.4	18.4	75.2	39.2	65.60
October	25.2	16.3	60.2	35.6	12.5
November	23.2	15.4	55.4	30.3	3.8

Source: SAU mini weather station, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

Appendix II. Soil test result of the experimental field reported by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Element	Levels in the soil plot
pH	5.9
N	0.071%
K	0.31 meq/100g soil
Ca	6.36 meq/100g soil
P	14.04 µg/g soil
S	15.16 µg/g soil
B	0.30 µg/g soil

Appendix III. Effect of seed size, red chili powder and bleaching powder on emergenceof mungbean

Sources of variation	DF	Mean square				
		% Emergence (days)				
		2nd	3rd	4th	5th	6th
Rep	2	0.986	3.737	55.79	55.79	55.79
SeedSize	2	128.570	262.013	691.80	691.80	691.80
Chili	1	504.002	871.627	1606.54	1606.54	1606.54
Bleaching	1	174.240	392.040	597.56	597.56	597.56
SeedSize*Chili	2	21.909	8.300	32.71	32.71	32.71
SeedSize*Bleaching	2	7.249	6.419	16.36	16.36	16.36
Chili*Bleaching	1	4.203	104.040	186.00	186.00	186.00
SeedSize*Chili*Bleaching	2	2.108	5.594	4.35	4.35	4.35
Error	22	1.549	1.189	34.38	34.38	34.38

Appendix IV. Effect of seed size,red chili powder and bleaching powder on the plant height ofmungbean

Sources of variation	Degrees of freedom	Mean square			
		Plant height (cm) at			
		15 DAS	30 DAS	45 DAS	Harvest
Rep	2	0.795	1.180	37.541	6.277
SeedSize	2	22.409	171.105	186.443	100.895
Chili	1	112.360	900.000	557.747	601.067
Bleaching	1	13.938	452.271	180.007	107.814
SeedSize*Chili	2	3.161	10.786	34.031	38.070
SeedSize*Bleaching	2	0.394	8.787	16.001	3.745
Chili*Bleaching	1	0.018	112.360	19.802	2.102
SeedSize*Chili*Bleaching	2	3.284	3.308	10.530	2.286
Error	22	0.555	3.558	7.171	4.512

Appendix V. Effect of seed size, red chili powder and bleaching powder on number of leaves of mungbean

Sources of variation	Degrees of freedom	Mean square			
		Number of leaves at			
		15 DAS	30 DAS	45 DAS	Harvest
Rep	2	0.00111	0.5503	0.695	1.33621
SeedSize	2	0.07111	11.1286	71.007	40.4669
Chili	1	0.02778	82.2044	128.823	173.976
Bleaching	1	0.09000	24.3378	42.903	45.2032
SeedSize*Chili	2	0.12444	1.3136	1.026	1.98210
SeedSize*Bleaching	2	0.16000	0.2353	0.021	0.08988
Chili*Bleaching	1	0.02778	5.2900	1.914	0.0001
SeedSize*Chili*Bleaching	2	0.12444	0.0058	0.585	0.31243
Error	22	0.10051	0.4263	0.385	0.41033

Appendix VI. Effect of seed size,red chili powder and bleaching powder on shoot dry weight plant^{-1} of mungbean

Sources of variation	Degrees of freedom	Mean square			
		Plant dry weight at			
		15 DAS	30 DAS	45 DAS	Harvest
Rep	2	0.00177	0.08536	0.0008	0.060
SeedSize	2	0.34785	3.51326	9.7147	31.787
Chili	1	3.24600	6.80340	15.4711	215.992
Bleaching	1	1.46814	4.52980	4.2162	64.053
SeedSize*Chili	2	0.04629	0.01302	0.2335	8.149
SeedSize*Bleaching	2	0.02580	0.04130	0.2272	0.495
Chili*Bleaching	1	0.23522	0.37414	0.0040	1.385
SeedSize*Chili*Bleaching	2	0.01236	0.09739	0.2426	2.229
Error	22	0.01558	0.14709	0.1744	0.163

Appendix VII. Effect of seed size, red chili powder and bleaching powder on nodules plant^{-1} of mungbean

Sources of variation	Degrees of freedom	Mean square		
		Number of nodules at		
		20 DAS	35 DAS	50 DAS
Rep	2	2.207	4.219	2.418
SeedSize	2	143.446	74.726	51.820
Chili	1	352.125	280.395	160.698
Bleaching	1	143.960	130.683	88.485
SeedSize*Chili	2	6.599	4.383	0.779
SeedSize*Bleaching	2	15.300	3.372	3.061
Chili*Bleaching	1	51.003	5.145	2.290
SeedSize*Chili*Bleaching	2	10.644	2.238	0.987
Error	22	1.386	1.417	2.182

Appendix VIII. Effect of seed size, red chili powder and bleaching powder on nodules dry weight of mungbean

Sources of variation	Degrees of freedom	Mean square		
		Nodules dry weight at		
		20 DAS	35 DAS	50 DAS
Rep	2	3.694E-04	0.00034	0.00005
SeedSize	2	1.119E-03	0.01460	0.00508
Chili	1	4.900E-03	0.02250	0.01138
Bleaching	1	3.600E-03	0.01068	0.00538
SeedSize*Chili	2	4.083E-04	0.00026	0.00031
SeedSize*Bleaching	2	2.583E-04	0.00020	0.00034
Chili*Bleaching	1	1.111E-03	0.00160	0.00001
SeedSize*Chili*Bleaching	2	3.611E-05	0.00093	0.00014
Error	22	7.551E-05	0.00019	0.00025

AppendixIX. Effect of seed size, red chili powder and bleaching powder on the number of branches plant^{-1} of mungbean

Sources of variation	Degrees of freedom	Mean square	
		Number of branches at	
		45 DAS	Harvest
Rep	2	1.13861	0.3558
SeedSize	2	0.15528	3.9608
Chili	1	0.00000	24.1736
Bleaching	1	4.00000	14.0625
SeedSize*Chili	2	4.78583	0.9169
SeedSize*Bleaching	2	0.98583	0.0175
Chili*Bleaching	1	0.09000	6.3336
SeedSize*Chili*Bleaching	2	2.14083	0.2269
Error	22	1.67073	0.5646

AppendixX. Effect of seed size, red chili powder and bleaching powder on the number of pods plant^{-1}of mungbean

Sources of variation	Degrees of freedom	Mean square	
		Number of pods plant^{-1}at	
		45 DAS	Harvest
Rep	2	2.61083	2.479
SeedSize	2	4.28583	106.534
Chili	1	0.81000	216.433
Bleaching	1	2.35111	32.585
SeedSize*Chili	2	4.11083	9.134
SeedSize*Bleaching	2	0.95528	0.284
Chili*Bleaching	1	0.25000	8.266
SeedSize*Chili*Bleaching	2	9.17583	0.097
Error	22	4.08235	0.896

AppendixXI. Effect of seed size, red chili powder and bleaching powder on the pod length, seeds pod^{-1} and 1000 seeds weight of mungbean

Sources of variation	Degrees of freedom	Mean square		
		Pod length	Seeds pod^{-1}	1000 pods weight
Rep	2	0.28882	9.943E-31	0.7
SeedSize	2	0.49361	3.00000	10432.9
Chili	1	2.10250	2.25000	34274.4
Bleaching	1	1.06778	0.00000	14224.5
SeedSize*Chili	2	0.01583	4.006E-32	931.8
SeedSize*Bleaching	2	0.02694	0.00000	172.2
Chili*Bleaching	1	0.16000	0.00000	4164.6
SeedSize*Chili*Bleaching	2	0.12250	0.00000	2555.8
Error	22	0.11473	3.735E-33	11.3

AppendixXII. Effect of seed size, red chili powder and bleaching powder on the pod yield, seed yield and harvest indexof mungbean

Sources of variation	Degrees of freedom	Mean square		
		Pod yield	seed yield	Harvest index
Rep	2	9375	0.00009	1.8817
SeedSize	2	589510	0.00028	11.7678
Chili	1	2957801	0.00123	20.7004
Bleaching	1	1451364	2.34090	18.0245
SeedSize*Chili	2	136604	0.00010	3.4232
SeedSize*Bleaching	2	211396	0.00006	7.4012
Chili*Bleaching	1	310450	0.00028	10.2942
SeedSize*Chili*Bleaching	2	187948	0.00001	12.3958
Error	22	11390	0.00002	2.3895

Plate 1. Field view of experimental plot at vegetative stage

Plate 2. Field view of experimental plot at reproductive stage

Plate 3. Crop at mature stage

Plate 4. Data collection and harvesting

Plate 5. Harvested pods