

**EFFECT OF ORGANIC SEED PRIMING ON SEED GROWTH AND YIELD OF  
DIFFERENT SOYBEAN VARIETIES**

**A THESIS**

**BY**

**MST. MAHANAZ AFRIN  
Student No. 1601245  
Session: 2022-2023  
Semester: January-June 2024**

**MASTER OF SCIENCE  
IN  
AGRONOMY**



**DEPARTMENT OF AGRONOMY  
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY  
DINAJPUR-5200**

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**DINAJPUR**

**JUNE 2024**

***DEDICATED  
TO MY  
BELOVED PARENTS  
AND  
AFFECTIONATE SIBLINGS***

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## EFFECT OF ORGANIC SEED PRIMING ON SEED GROWTH AND YIELD OF DIFFERENT SOYBEAN VARIETIES

### ABSTRACT

A pot experiment was conducted at research field-1 of Department of Agronomy Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200 during the period from December, 2023 to May 2024 to study the effect of organic seed priming on yield attributes and yield of the two soybean varieties. The experiment comprised of two factors: A. Two varieties of soybean viz;  $V_1$ = BARI Soybean-5,  $V_2$ = BARI Soybean-6, and B. Five seed priming treatments viz  $P_1$ = (control),  $P_2$ = (seed priming with 3% *Moringa* leaf extract),  $P_3$  (seed priming with 6% *Moringa* leaf extract) ,  $P_4$ = (seed priming with 2% *aloe vera* extract) and  $P_5$ = (seed priming with 4% *Aloe vera* extract) were considered as treatments of the experiment. The experiment was layout by completely randomized design (CRD) with three replications it consisted of ten different treatment combinations. Thus, there were 30-unit pots in this experiment. The maximum of growth parameters of soybeans were found statistically significant such as plant height (cm) in different days of interval (20, 40, 60 days after sowing and at harvest), number of branch plant (no.) also at (40, 60 days after sowing and at harvest), number of pods plant (no.), pod length (cm), number of seeds pod (no.), weight of 100-seed (g), seed yield (g plant<sup>-1</sup>), stover yield (g plant<sup>-1</sup>) biological yield (g plant<sup>-1</sup>) and harvest index (%). However considering the varietal characteristics the maximum seed yield (1.77 g plant<sup>-1</sup>) was observed in BARI Soybean-6 ( $V_2$ ) while minimum (1.51 g plant<sup>-1</sup>) was produced by BARI Soybean-5 ( $V_1$ ) and also maximum Stover yield (3.56 g plant<sup>-1</sup>) recorded in BARI Soybean-6 while the minimum was found (3.36 g plant<sup>-1</sup>) from BARI Soybean-5( $V_1$ ). In case of different priming treatments, the effect of 6% *Moringa* leaf extract ( $P_3$ ) generated the maximum seed yield (1.96 g plant<sup>-1</sup>) whereas no priming ( $P_1$ ) produced the minimum seed yield (1.17 g plant<sup>-1</sup>). Priming with 2% *Aloe vera* extract showed the maximum (3.63 g plant<sup>-1</sup>) stover yield and no priming treatment showed the minimum (3.05 g plant<sup>-1</sup>) results respectively. In treatment combination,  $V_2P_3$  generated maximum (2.12 g plant<sup>-1</sup>) seed yield and stover yield (3.68 g plant<sup>-1</sup>) whereas the minimum seed yield (1.01 g plant<sup>-1</sup>) and stover yield (3.00 g plant<sup>-1</sup>) were recorded from  $V_1P_1$  treatment combination. So, it may be suggested that BARI Soybean-6 ( $V_2$ ) primed with 6% ( $P_3$ ) showed better result for growth and yield of Soybean.

Key words: BARI Soybean-4, BARI Soybean-5, *aloe vera* leaf extract, *moringa* leaf extract

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# CHAPTER I

## INTRODUCTION

Soybean (*Glycine max* L.) is an important legume crop which is grown in tropical, subtropical and temperate climates. It belongs to the botanical family of Fabaceae, and subfamily of Papilionideae. It is also an important oilseed and protein crop of the world. It accounts for approximately 50% percent of the total production of global oilseed crops (BARI, 2006). It is a good source of unsaturated fatty acids, minerals like Ca and P including vitamin A, B, C and D can meet up different nutritional needs (Rahman, 1982). It has nutritional value, provides the richest source of protein of any other crops (same levels of cow's milk and meat, poultry or fish) and is able to serve as the core protein supplement to human diets. Soya cake serves as an outstanding source of protein for livestock (MoFA and CSIR, 2005). Processing soybean products like tofu, constitutes good nutritional quality for adult humans and contain a high amount of 40%–50% protein, 20%–30% lipids and 26%–30% carbohydrates (Gibbs *et al.*, 2004). Soybean is abundant in essential fatty acids, including saturated, monounsaturated and polyunsaturated fatty acids (USDA 2018), and contains beneficial secondary metabolites such as isoflavones, phenolic components (Sakthivelu *et al.*, 2008). A good source of low-cost protein and other nutritive factors for humans as well as for use in poultry feed. soybean is thus a valuable crop for both developed and developing nations (Khojely *et al.*, 2018). Worldwide, the total annual production of soybean is 365.79 million tons from an area of land totaling 130.90 million hectares. In Bangladesh, total annual production is 96,921 tons from a cultivated area of 62,870 hectares at 1.54 tons/ha, this is much lower than the world average of 2.79 tons/ha (CIMMYT 2022).

The 2024/25 global production of major grains, including wheat and soybeans, is projected to reach 2.967 billion tonnes, up by 1.3% from the previous marketing year (BBS, 2023/24), and the projected 2024/25 ending stocks are 870 million tonnes, up by 1.5% from the previous marketing year. Thus, the global supply of major grains is forecast to be on stability. The relevant industry in South Korea has already procured six months of grain supplies, which is bringing down the import prices of wheat, soybeans, and corn.

Choi (2024) Amid climate change-caused weather events such as floods in Brazil, La Nina, etc., the Ministry of Agriculture, Food and Rural Affairs (MAFRA) has been preemptively preparing for factors that may cause instability of grain supply by carrying out diverse countermeasures, including strengthening monitoring of the global grain market trend, operating an early warning system, and procuring an appropriate amount of grain stocks.

Soybean oil has gained popularity in modern day cooking in Bangladesh. Extraction from soybean seed is not yet possible using traditional methodologies. Most of the soybean that the country produces is used in the feed industries, and any soybean oil in the market is imported. The multipurpose use of soybean is increasing day by day in our country. April 2023 projection of the United States Department of Agriculture (USDA), Bangladesh's current yearly demand for soybean oil stands at 2.4 million tons and that of palm oil 1.6 million tons. Bangladesh is heavily dependent on import to meet its oils and fats requirements. With 0.8 million tons of yearly crude soybean oil imports, Bangladesh stands behind only India and China among top oil and oilseed importing countries. Every year, Bangladesh pays import bill of 2 billion dollars to meet its edible oil needs (Dhaka Tribune, 2021). Bangladesh could meet 40 percent of its soybean oil demand by producing Soybean locally, as there is a bright prospect for its farming.

There is a bright prospect for local soybean production and we could meet 40 percent of our local demand of soybean oil if proper government support is available (The Daily Star 2009).

As a leguminous crop, has the ability to fix atmospheric N through root nodule bacteria (*Bradyrhizobium japonicum*) and enrich the soil fertility (Kureh *et al.*, 2005). This can compensate 80-90% demand for nitrogen by the crops. Because of its high nutritional value and myriad form of uses, it is recognized as "Golden Bean" and has become the miracle crop of the 21<sup>st</sup> century.

In Bangladesh, there are ample opportunities to increase both the area and productivity of oilseed crops such as soybean because of the availability of short-duration improved varieties and suitable agro-climatic conditions. At the same time, at the production and post-harvest processing levels there is some potential for mechanical interventions. These might enhance current oilseed production and processes and allow farmers to earn more from soybean cultivation (Miah and Mondal, 2017). Soybean is gradually gaining

popularity as a cash crop, especially among farming households in the country's southern belt (Noakhali, Lakshmipur and Bhola districts). The socio-economic condition of these farming communities could be potentially enhanced through the establishment of small soy-based food manufacturing industries, producing milk, flour/breads, meat, biscuits and assorted snacks, all from soybean.

Average yield of soybean is much lower due to lack of improved agricultural practices of which different plant growth regulators application and stages of application and plant growth regulators is an important determinant for better performance of soybean. Plant growth regulators (PGR's) are organic compounds, which in small amounts, somehow modify a given physiological plant process. Plant growth regulators are known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimate enhance productivity of the crops. Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance the effective partitioning of accumulates from source and sink in the field crops (Solamani *et al.*, 2001).

Seed priming is a seed treatment that regulates the germination process by managing the temperature and seed moisture content. The seed is taken through a biochemical process within that activates the initial stages of germination. The priming process regulates the seed's temperature and moisture content, bringing the seed closer to the point of germination and then carefully dried to stop germination for planting. Basically, the priming process advances the seed to the same stage of maturity so that the seed will emerge uniformly in the field. When the primed seeds are planted, you are shortening the germination time and improving the uniformity of the crop upon emergence.

Seed priming is one of the key solution to overcome these problems and is very simple to adopt and being a low cost technology too, especially for dry land farmers. Priming is one of the most important physiological methods which improves the seed performance and provides faster and synchronized germination. The primed seeds give earlier, more uniform and greater germination and seedling establishment and growth.

Organic seed priming provides resistant to high temperature and low moisture especially in semiarid tropics. It encourages quicker germination, greater seedling vigour resulting in increased crop productivity especially in advanced countries it integrates the

biological and physiological aspects of enhancing growth, disease control and increase in yield (Iswariya *et al.*, 2019).

Hence, Therefore we undertaken the study to observe the performance of Organic priming (*Moringa* and *Aloevera* extract) on Growth, yield and yield attributes of soybean.

**Objectives:**

- i. To find out suitable priming for maximum growth and yield of soybean
- ii. To detect the appropriate variety of soybean for different region of Bangladesh.
- iii. To assess the interaction effect of seed priming and of soybean variety.

## CHAPTER II

### REVIEW OF LITERATURE

Soybean is quite wide spread in different regions of the world and seems to grow well from the tropical and subtropical regions. Soybean is one of the leading oil and protein containing crops of the world and as well as Bangladesh. One of the critical factors for low productivity of soybean is low germination. Productivity of crop depends on high germination and better crop stand. Now days, there is much problem related to poor germination and crop establishment. Seed priming is a tool to enhance the germination and retain high vigor. In this chapter an attempt has been made to review the available information in home and abroad regarding the performance of different priming on different crops cultivation.

According to Singh *et al.* (2015) strategies for improving the growth and development of crop species have been investigated for many years. Rapid germination and emergence are essential for successful crop establishment for which seed priming could play an important role. Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield. It is a simple and low-cost hydration technique in which seeds are partially hydrated to a point where pre-germination metabolic activities start without actual germination, and then re-dried until close to the original dry weight. Seed priming is employed for better crop stand and higher yields in a range of crops.

Rehman *et al.* (2011) reported that seed priming is a cost-effective technology that can enhance early crop growth leading to earlier and more uniform stand with yield associated benefits in many field crops including oilseeds. Various seed priming techniques have been developed which include hydro-priming, halopriming, osmo-priming and hormonal priming. Hydro-priming soaking the seeds in water before sowing and may or may not be followed by air drying of the seeds. Hydro-priming may enhance seed germination and seedling emergence under both saline and non- saline conditions.

Harshavardhini *et al.* (2021) conducted an experiment at the Postgraduate Seed Testing Laboratory of the Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, the performance of organic and botanical treatments on cowpea seed quality

was assessed. The Cowpea cultivar Kashi Kanchan seeds were utilized for priming. Organic treatments included varying concentrations of Panchagavya (2%, 4%, 6%, 8%) and Jeevamruth (1%, 3%, 5%, 7%), while botanical treatments comprised Curry leaf extract 5%, *Moringa* leaf extract 5%, and Seaweed extract 5%, each applied for a duration of 10 hours. Results indicated that among all treatments, T11 (Seaweed extract 5%) exhibited superior performance in germination percentage, root length, shoot length, seedling length, seed vigor index-I, and seed vigor index-II. This effectiveness is attributed to the presence of multiple growth regulators such as cytokinins, auxins, Gibberellins, and essential plant nutrients within the seaweed extract. The findings suggest that seaweed extract at a 5% concentration positively influences cowpea seed quality parameters under simulated environmental conditions.

The study conducted by Naikwade Pratap Vyankatrao (2019) issue of the Online International Interdisciplinary Research Journal, explores the impact of organic liquid treatments, particularly Bijamrita, on seed germination and seedling growth of legume crops. Bijamrita is a seed treatment technique utilizing locally available ingredients, such as cow dung and cow urine, known for their germicidal and medicinal properties in India. The experiment focused on four major legume crops commonly grown in Maharashtra: Groundnut, Soybean, Moth Bean, and Green Gram. Seven treatments, including different concentrations of Bijamrita (25%, 50%, 75%, 100%), local desi cow dung extract, local desi cow urine, and a control, were applied to seeds, with four replicates each. Results revealed that Bijamrita and other organic treatments, easily prepared from locally available ingredients, enhanced the seed germination percentage for all four legume crops. Additionally, root, shoot, and total seedling lengths increased with the application of organic liquid formulations. Among different concentrations, 100% Bijamrita demonstrated the highest germination percentage, seedling growth, and Seed Vigour Index, recommending its use in agriculture to reduce dependence on chemical treatments and subsequently mitigate pollution.

Harris *et al.* (1999) reported that Poor crop establishment was a significant challenge identified by farmers in tribal villages of Rajasthan, Gujarat, and Madhya Pradesh under the Krishak Bharati Cooperative (KRIBHCO) Indo-British Rainfed Farming Project (KRIBP). On-farm seed priming with water was adopted as a cost-effective and low-risk intervention to address this issue. In vitro screening determined "safe limits" for seed priming – 24 hours for maize and rice and 10 hours for chickpea, with minor varietal

differences. Farmer-managed trials conducted in multiple villages demonstrated that farmers modified the recommendations to "overnight" for all three crops. Evaluation through focus group discussions, matrix ranking exercises, and workshops revealed direct benefits such as faster emergence, better stands, lower re-sowing, vigorous plants, improved drought tolerance, earlier flowering, early harvest, and higher seed yield across all three crops. Indirect benefits included earlier sowing of rabi crops, leading to earlier migration and increased willingness to use fertilizers due to reduced crop failure risk. Matrix ranking exercises indicated high farmer acceptance, with 95% intending to adopt seed priming after one exposure in kharif 1996 and 100% planning to continue in rabi 1996-97. Workshops involving 246 farmers from 21 villages further confirmed their resolve to continue with seed priming technology.

Sangameshwari and Kumarimanimuthu (2022) conducted an experiment on Organic seed priming – a feasible approach for inducing germination efficiency in cotton. Seed priming, a pre-sowing treatment enhancing seed germination efficiency, was studied in cotton at Annamalai University. The experiment, following a randomized block design, included treatments such as hydro priming, NSKE, panchagavya @ 3%, and Liquid bio-fertilizer (Azo gold). Among these, seed priming with panchagavya @ 3% exhibited superior germination and growth responses. The method proved to be cost-effective and environmentally friendly. Results emphasized its effectiveness in promoting cotton seedling vigor. This alternative and feasible technique showcased considerable benefits in terms of increased germination and growth in cotton.

Wajid *et al.* (2021) reported that pulses, known as "poor man's meat," are vital protein sources complementing cereals in diets. Field pea, a cool-season grain legume, is a major rabi pulse in India. A study investigated the impact of various organic and inorganic seed priming methods on field pea (*Pisum sativum* L.) during Rabi-2019 at Sam Higginbottom University. Thirteen treatments, including control and various priming agents, were evaluated in a randomized blocked design for field studies and a completely randomized design for lab studies. Seeds primed with KN03 @ 3% demonstrated the most significant improvements in germination, growth, yield, and seed quality parameters, followed by Neem Leaf Extract @ 5%. The least performance was observed in the control group. Therefore, seed priming with KN03 @ 3% and Neem Leaf Extract @ 5% is recommended for enhancing the performance of field pea as a pre-sowing seed treatment.

Sharma *et al.* (2014) carried out an experiment on comparison of various seed priming methods for seed germination, seedling vigour and fruit yield in okra. Seed priming, a method to enhance seed germination and plant growth, was investigated for its effects on okra in this study. Four priming methods, including hydropriming, osmopriming, halopriming, and solid matrix (SM) priming, were applied in 19 treatment combinations, along with a control. The study assessed various physiological and biochemical parameters, such as seed germination, mean germination time, seedling vigor, seed viability, electrical conductivity, lipid peroxidation, dehydrogenase activity, antioxidant enzymes, reserve mobilizing enzymes, and field performance. Hydropriming for 12 hours and SM priming with calcium aluminum silicate (1:0.4:1; Seed:SM:Water) for 24 hours significantly improved seed germination, seedling vigor, mean germination time, and marketable fruit yield in okra (cv. Hisar Unnat). Hydropriming, due to its simplicity, cost-effectiveness, and safety, is recommended, showing the potential to increase fruit yield by up to 55% compared to the control.

Jayanth *et al.* (2017) carried out an experiment in Seed science post Graduate Laboratory, Department of Genetics and Plant Breeding, SHUATS, Allahabad, U.P. In order to standardize the best method of Organic priming specific to cotton, two methods of priming viz., Organic priming and hydropriming and they were evaluated by screening a range of durations and concentrations viz., T0-Unprimed Control, T1-Distilled water hydration (for 12 hrs), T2-Cow urine at 2%, T3-Cow urine at 6%, T4-Cow urine at 10%, T5-Curry leaf extract 6%, T6-Curry leaf extract 10%. It found that all the Organic priming methods showed significance difference with the control and the highest germination %, seedling length (cm), seedling fresh weight (g), seedling dry weight (g) and vigour index were observed in T3 for Cow urine at 6%. The study helps to improve the quality of seeds with the help of seed organic priming treatments which are cost effective and economic, nontoxic, ecofriendly sources.

Ambika *et al.* (2015) carried out an experiment at Department of Seed Science and Technology, Agricultural College and Research Institute, Madurai during 2014-2015, to find out the effect of organic seed priming with cow urine at different concentrations. The cluster bean seeds were soaked for 3 h with different concentrations viz., 2, 4, 6, 8 and 10% along with water and control (no treatment). The seed quality parameters viz., speed of germination, germination, root length, shoot length, vigour index I, vigour index II and dry matter production were evaluated. The best performance was observed in cow

urine (2%) by recording highest seed quality parameters. The percentage increase over control was 10.52, 8.16, 9.8, 8.0, 16.34, 15.36 and 7.8 for speed of germination, germination percentage, root length, shoot length, vigour index I, vigour index II and dry matter production, respectively.

Sutheesh *et al.* (2016) carried out an experiment on evaluation of organic and inorganic pretreatments for better seed germination and seedling vigour in *Santalum album*. The study focused on evaluating the impact of various seed pretreatments on the germination and seedling vigor of *Santalum album* (East Indian sandalwood). Sixteen pretreatments, including soaking in tap and boiling water, acid scarification, and treatments with GA<sub>3</sub>, cow dung slurry, and cow urine at different concentrations and durations, were applied to mature seeds collected from Marayoor Nachivayal forest in Kerala. The highest germination percentage (74.33%) was observed in seeds soaked in 500 mg l<sup>-1</sup> GA<sub>3</sub> for 24 hours (T8), while the lowest (44.33%) was noted in seeds soaked in H<sub>2</sub>SO<sub>4</sub> for 5 minutes (T5). Acid scarification and boiling water treatments decreased germination compared to the control. GA<sub>3</sub> treatment exhibited the highest germination energy (44.67%), and soaking in cow dung slurry for 24 hours (T10) showed comparable germination energy (38%). GA<sub>3</sub> pretreatment was identified as the most effective, followed by cow dung slurry, particularly the 24-hour duration, offering a cost-effective alternative for farmers in nurseries. However, no clear pattern of pretreatment influence on seedling traits was observed after one month.

Hernández-Herrera *et al.* (2014) carried out an experiment on Effect of liquid seaweed extracts on growth of tomato seedlings (*Solanum lycopersicum* L.). Seaweed extracts are used as nutrient supplements, biostimulants, or biofertilizers in agriculture and horticulture to increase plant growth and yield. In this study, we examined the effect of liquid seaweed extracts (LSEs) made from *Ulva lactuca*, *Caulerpa sertularioides*, *Padina gymnospora*, and *Sargassum liebmannii* as biostimulants on the germination and growth of tomato (*Solanum lycopersicum*) under laboratory and greenhouse conditions using foliar and soil drench applications of LSEs. We assessed LSEs at different concentrations (0.2, 0.4, and 1.0 %) on germination parameters (percentage, index, mean time, energy, and seedling vigor index) and growth parameters (plumule length, radical length, shoot length, root length, fresh weight, and dry weight) of tomato seedlings. Our results indicate that seeds treated with LSEs of *U. lactuca* and *P. gymnospora* at lower concentrations (0.2 %) showed enhanced germination (better response in germination

rate associated with lower mean germination time, high germination index and germination energy, and consequently greater seedling vigor and greater plumule and radicle length). Application as a soil drench was found to be more effective in influencing the height of the plant (up to 79 cm) than the foliar spray application (75 cm). Plants receiving LSEs of *U. lactuca* and *P. gymnospora* showed increased shoot length, root length, and weight. Furthermore, *U. lactuca* and *P. gymnospora* were found to be more successful and better candidates for developing effective biostimulants to improve the growth of tomato plants. This study provides important information on the identification and utilization of Mexican seaweed resources for agriculture and is the first study to report on the uses of these seaweeds as a source of liquid extracts as biostimulants in agriculture.

Dilavarnaik *et al.* (2017) a study was conducted to determine the influence of seaweed saps [*Gracilaria edulis* (G sap) and *Kappaphycus alvarezii* (K sap) on germination, growth and Seedling Vigor Index (SVI) under laboratory conditions followed by a field experiment to examine its foliar application on growth and yield of hybrid maize. Bioassay results revealed that soaking maize seeds in various concentrations from 5% to 15% either with G or K sap significantly increased the germination percentage (96.67%) at 5% level. However, higher shoot length (7.66 and 8.67cm), SVI (3410 and 3661) at 7th and 15th days and dry weight of seedlings (0.92g) were recorded in 15% K sap soaked seeds. Field experiment involved in soaking of maize seeds in seaweed saps followed by foliar application at different intervals. Results revealed that application of seaweed sap for maize crop with G or K saps at varied concentration, significantly increased cob length (17.63cm), number of grains (568.33g) and grain weight cob<sup>-1</sup> (56.22g), test weight (33.67g), grain and stover yield (4377.10 and 5764.31 kg ha<sup>-1</sup> respectively), were recorded when seeds were treated with 15%G sap along with 10%G sap spray at 20, 40 and 70 days after sowing. This study clearly indicated the benefit of seaweed sap application to maize crop particularly, 15%G sap seed soaking followed by G sap spray in increasing the maize yield.

Challen *et al.* (1965) exploitation of seaweed as a manure has only met with variable success owing to rising cost of collection and transportation of the raw material, the introduction of mineral fertilizers, and the lack of published scientific evidence about the value of seaweed as a plant nutrient. Results of some controlled field experiments indicate that seaweed is of benefit to crops while other evidence is contradictory. It is

probable that erratic results have been due to variation in any of the following: climatic and soil conditions of field experiments, botanical and geographical source of seaweed, method of seaweed processing, and form of seaweed products. The authors have set out to demonstrate on a small scale whether or not seaweed extracts promote the growth of higher plants and have begun an analysis of the factors which affect the response. A method of screening seaweed extract has been employed using vermiculite as culture medium, with mustard, *Sinapis alba*, as test plant and growth was determined by measuring height of seedlings, also fresh weight and dry weight. Extracts of fresh seaweeds were prepared and their effects on the growth of mustard compared with those of a commercial seaweed extract. Significant results were obtained twenty days after germination of the seed and the method is useful for giving a fairly rapid assessment of the growth response obtainable with numerous batches of seaweed extracts.

Arthur *et al.* (2003) study on effect of seaweed concentrates on the growth and yield of three varieties of capsicum annum. The effect of different modes of application of Kelpak on the growth and yield of three varieties of greenhouse cultivated peppers was investigated. In most instances, application of Kelpak improved the marketable fruit yield. A combined treatment of dipping the seedlings in 0.4% Kelpak solution for 2h prior to transplanting followed by three applications of 0.4% Kelpak as a foliar spray during the growth of the plants significantly increased the number and size of the marketable fruit.

Nawaz *et al.* (2024) experiment on organic seed priming with curtailed seed rate compensated wheat grains productivity by upgrading anti-oxidant status against terminal drought at flowering and milking. Terminal irrigation drought stress is one of the most drastic abiotic stress to diminish the wheat crop development and grains yield in arid regions of the world. The use of *Moringa* leaf extract (MLE30) via seed priming technique is investigated as an organic and sustainable approach for the mitigation of drought stress along with curtailed seed rate in wheat crop. The study investigated the interaction of organic seed priming: control (dry seeds), hydro-priming, MLE30-priming, seed rate: recommended @ 125 kg ha<sup>-1</sup>, curtailed @ 25 kg ha<sup>-1</sup>, and terminal irrigation drought (TID): normal irrigation, mild-TID, severe-TID in wheat crop at agronomic research station, Bahawalpur, Pakistan during the wheat winter season of 2021–2022 and 2022–2023. The application of organic MLE30-priming with curtailed seed rate enhanced antioxidant enzyme activity especially total soluble proteins by 15%,

superoxide dismutase by 68%, peroxidase by 16%, catalase by 70%, ascorbic acid by 17% and total protein contents by 91% under severe-TID. Yield and yield-related morphological attributes performed better in MLE30-priming as compared to hydro-priming. An effective trend was observed in the plant's chlorophyll contents, K<sup>+</sup>, and water use efficiency after being treated with MLE30-priming followed by hydro-priming under curtailed seed rate. The higher benefit–cost ratio and net income return were observed with the application of MLE30-priming with curtailed seed rate under mild-TID and severe-TID. So, it is suggested to adopt the MLE30-priming technique along with a curtailed seed rate for improving the crop establishment, stress regulation, and economic return under limited availability of irrigation water. The project findings recommended that the application of exogenous application of organic MLE30-seed priming favored and compensated the maximum wheat grains production under curtailed seed rate @ 25 kg ha<sup>-1</sup> and induced terminal drought stress at flowering and milking conditions.

Rouhi *et al.* (2011) say priming treatments have been used to accelerate the germination and seedling growth in most of the crops under normal and stress conditions. For susceptible and low vigor soybean seed, this technique would be a promising method. At first, in separate experiment, effects of hydropriming for (12, 24, 36 and 48 h) with control (none prime) were evaluated on germination traits of soybean seed lots cv. ‘Sari’ (include 2 drying method and 3 harvest moisture). Then, next experiment was conducted to determination the best combination of osmopriming in soybean seed lots, hence 3 osmotic potential level (-8, -10 and -12 bar) at 4 time (12, 24, 36 and 48 h) were compared. Analysis of variance showed that, except for seedling dry weight, the other traits include standard germination, germination rate, seedling length and vigor index were influenced by osmopriming. Hydropriming had no effect on these traits and decreased rate of germination. Finally the best combination of osmopriming were osmotic potential -12 bar at 12 hours for time, that submitted acceptable result in all conditions and recommended for soybean seed lots cv. ‘Sari’.

Lewandowska *et al.* (2020) reported on the experiment on influence of priming on germination, development, and yield of soybean varieties. A two-factorial field experiment with soybean [*Glycine max* (L.) Merrill] was conducted in a seed priming method and genotype responses. There had been seven soybean varieties (Aldana, Aligator, Annushka, Augusta, Lissabon, Mavka, and Merlin) and each of them had

control (unprimed) and seed primed groups. The aim of this study was to determine the effect of hydropriming on germination ability and emergence under field conditions, on the growth and development of selected soybean varieties. Shortly before harvest, 10 randomly selected plants were collected from each plot, and their morphological and yield-related traits were measured. On the basis of statistical analysis, significant differences were found between the applied hydropriming method and the control group in regard to morphological traits. Seed treatment resulted in a slight increase in harvested seed yield, which is within error margin. The seed yield of Aligator increased significantly by  $0.5 \text{ t ha}^{-1}$ , indicating a genotype-specific different reaction to seed priming in terms of yield.

Satani *et al.* (2021) study on Effects of Pre-sowing Organic Priming on Seed Germination Pre-sowing organic seed priming helps to improve germination and stand establishment. They reported that regular use for seed priming will reduce dependence on chemicals and subsequently reduce pollution caused by chemical priming. The various Pre-sowing organic priming was soaking the seeds in hot or normal water, soaking the seeds in a cow-dung paste, different cow urine concentrations, ash, etc. This article reviews the comparative effects of various organic priming methods in improving seed germination, seedling emergence, seedling vigor, seed structure, yield production, etc. The present review aims to study the effect of different priming methods on improving seedling growth of different plants.

Soujanya *et al.* (2024) an experiment was conducted in the Vegetable Unit, Department of Horticulture, Annamalai University, Chidambaram, Tamil Nadu during 2022 to find out the effective seed priming method in bhendi which includes different organics in different concentrations *viz.*, Panchagavya @ 2% and @ 4%, Cow urine @ 2% and 4%, Vermiwash @ 0.1% and 0.25%, Beejamrutham @ 2% and 4%, Coconut water @ 25% and 50% and Control. The results of the experiment demonstrated that among the organic seed priming evaluated, Coconut water @ 50% has resulted in a higher germination percentage, speed of germination, shoot length, root length, seedling length, seedling fresh weight, dry weight and seedling vigour index.

Bhavyasree *et al.* (2019) say that brinjal crop production is adversely affected by its reduced germination percentage. Orgo priming of the brinjal seeds are having several positive effects on the seed quality and thereby increase the germination percentage. So

an experiment was carried out to utilize several organo priming techniques for the improvement of seed vigor and to find their efficient concentration. As organo priming agents, varying concentrations of Panchagavya, Cow urine and Coconut water were used. The treated seeds along with control were evaluated for their seed quality parameters under laboratory condition resulted a higher germination percentage with enhanced seed quality parameters in seeds primed with coconut water followed by cow urine. The best priming treatment recorded higher seed germination, root length, shoot length, dry matter production and vigour index which were by using coconut water as compared to other treatments. This proved that the organo priming can be an effective way to enhance the seed quality in brinjal.

Lakmali *et al.* (2022) was carried out to study the effect of seed priming with coconut water on the growth and yield of okra (*Abelmoschus esculentus* L. Moench). It was carried out with six treatments comprised of different percentages of king coconut water, T1 - 0%, T2 - 4%, T3 - 8%, T4 - 12%, T5 - 16% and T6 - 20%. The results confirmed that the seed priming with coconut water had significant differences in average values of plant height, number of leaves per plant, number of branches per plant, number of immature pods per plant, root length, number of seeds per immature pod, fresh weight of seed per pod, fresh weight of marketable pods per plant at each picking, total marketable pod weight (g) per plant, total marketable pod weight (g) per m<sup>2</sup> and total marketable pod weight (kg) per ha. But, average values of length, girth and fresh weight of immature pod were not significantly affected ( $P>0.05$ ) by the seed priming treatment. According to the statistically analysed results, 12% king coconut water gave a higher marketable pod yield of okra which could be recommended for future use. Coconut water is a cheap and readily available resource, thereby it could be used for enhancing the growth and yield of crops by the seed priming induction process.

Amarnath *et al.* (2015) find out the Effect of priming with botanicals and animal waste on germination and seedling vigour in sorghum (*Sorghum bicolor* L.) seeds experiments was conducted to evaluate the effect of different seed priming techniques on germination and morphological characters of sorghum an experiment was conducted in 2013-2014 in a experiment based on the complete randomized block design with two variety M35-1 (Muguti 35-1) and DSH (Dharwad sorghum hybrid). Seeds were primed for six priming media (T0- hydro priming control, Neem Leaf Extract, Parthenium Leaf Extract, Cow Urine, Coconut water and Lantana Camara Extract). Maximum seed germination

percentage was observed when seed primed by Coconut water @ 3 % is best for germination %, root length, seedling length, seed vigour length, seedling shoot length, total germination and seed vigour index, followed by Cow Urine @3% similar trend was also observed in all treatment. Among the treatments LCE recorded minimum root length, germination %, Seedling Length, Seed Vigour Length, Seedling shoot length, total germination and Seed Vigour index. Among all the priming treatments, coconut water @3% was found to be the best priming treatment. Moreover priming treatments have more pronounced effect DSH maintained highest quality parameters followed than M35-1 of sorghum seeds.

Jayashri *et al.* (2015) reported that Successful establishment of plants largely depends on successful germination. This study examined the effects of different methods of seed priming on germination percentage, germination index, time of 50 per cent emergence, mean germination time, root and shoot length, dry weight of seedling and vigour index of maize. The experiment was conducted in the laboratory of Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during 2013-14 using Completely Randomized Design with three replications. All growth and developmental parameters of maize seed were positively responded with seed priming in comparison to unprimed treatment. Bio-priming of maize seed for 24 hours showed the highest positive effect on all the parameters and recorded significantly highest values of germination percentage (93.11), germination index (29.84), root length (22.73 cm), shoot length (19.67), seedling dry weight (1.56 g) as well as seedling vigour index (3947.49). The level of T 50 (1.51 days) and MGT (2.14 days) were the lowest due to bio-priming for 24 hours in comparison to other priming treatments.

Harris *et al.* (1999) was identified as a major constraint on rainfed crop production by farmers in the tribal villages of Rajasthan, Gujarat and Madhya Pradesh served by the Krishak Bharati Cooperative (KRIBHCO) Indo-British Rainfed Farming Project (KRIBP). On-farm seed priming with water was chosen as a low cost, low risk intervention appropriate to the farmers' needs. In vitro screening of the effects of priming on the germination of seeds of local and improved varieties of maize, upland rice and chickpea provided 'safe limits' – the maximum length of time for which farmers should prime seeds and which, if exceeded, could lead to seed or seedling damage. Recommended safe limits were 24 h for maize and rice and 10 h for chickpea, with only minor varietal differences. These recommendations were then tested in on-station trials

in Dahod, Gujarat. Farmer-managed trials were conducted for chickpea in three villages in the rabi (post-monsoon) season in 1995–96; for maize and upland rice in eight villages in the kharif (monsoon) season in 1996; and for maize and chickpea in 15 villages in the 1996-97 rabi season. Farmers modified these recommendations to ‘overnight’ for all three crops. Evaluation of the technology by farmers involved focus group discussions, matrix ranking exercises and two workshops. Direct benefits in all three crops included faster emergence, better stands and a lower incidence of re-sowing, more vigorous plants, better drought tolerance, earlier flowering, earlier harvest and higher seed yield. Indirect benefits reported were earlier sowing of rabi crops because of the shorter duration of the preceding kharif crop, earlier harvesting of rabi crops that allowed earlier migration from the area, with better chance of obtaining off-season work, and increased willingness to use fertilizers because of reduced risk of crop failure. In matrix ranking exercises in four villages in the kharif 1996, 95% of farmers indicated that, even after only one exposure to the technology, they would prime seed in the following season. Similar exercises in four villages in rabi 1996–97 revealed that 100% of collaborating farmers intended to continue seed priming. From 21 villages, 246 farmers attended two workshops to share their experiences of seed priming and resolved to continue with the technology.

## **CHAPTER III**

### **MATERIALS AND METHODS**

This chapter presents a brief description about experimental period, site description, climatic condition, crop or planting materials, treatments, experimental design and layout, crop growing procedure, fertilizer application, intercultural operations, data collection and statistical analyses.

#### **3.1 Experimental period**

The experiment was conducted during the period from December 24, 2023 to May 19, 2024 in Rabi season.

#### **3.2 Description of experimental site**

##### **3.2.1 Geographical location**

The pot experiment was conducted at the Agronomy research field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur. The experimental area was located at 25°44.574" N and 88°40.344" E longitude at an elevation of 40 m above from the sea level.

##### **3.2.1 Agro-Ecological Zone**

The experimental site was belong to the Agro-ecological Zone “AEZ-1” Old Himalayan Piedmont Plain (Anon., 1988). This was a region of complex relief and deep, rapidly permeable sandy loams and sandy clay loams are predominant in this region. Organic matter contents are generally higher than in most floodplain soils of Bangladesh (Anon., 1988). The location of the experimental site has been shown in Appendix I.

#### **3.3 Climate of the experimental site**

The experimental area is situated in the hot, wet and humid tropical climate. Under the Köppen climate classification, Dinajpur has a tropical wet and dry climate. The district has a distinct monsoonal season, with an annual average temperature of 25 °C (77 °F) and monthly means varying between 18 °C (64 °F) in January and 29 °C (84 °F) in August. The Rabi season (October to March) is characterized by comparatively low temperature and plenty of sunshine from November to February. Plenty of sunshine

prevails during experimental period, which is suitable for soybean growing in Bangladesh. The weather data during the study period at the experimental site are shown in Appendix II.

### **3.4 Soil**

The soil of the research field is slightly acidic in reaction with low organic matter content. The selected plot was above flood level and sufficient sunshine was available having available irrigation and drainage system during the experimental period. The experimental plot was also high land, having pH 5.8.

### **3.5 Details of the experiment**

#### **3.5.1 Experimental treatments**

The experiment consisted of two factors such as Soybean Variety and seed of priming concentrations. The treatments were as follows:

#### **Factor A: Variety**

V<sub>1</sub>: BARI Soybean-5

V<sub>2</sub>: BARI Soybean-6

#### **Factor B: Seed priming**

P<sub>1</sub>: Control (without priming)

P<sub>2</sub>: 3% *Moringa*

P<sub>3</sub>: 6% *Moringa*

P<sub>4</sub>: 2% *Aloe vera*

P<sub>5</sub>: 4% *Aloe vera*

**There were 10 (5\*2) treatment combinations such as**

- V<sub>1</sub>P<sub>1</sub> • V<sub>2</sub>P<sub>1</sub>
- V<sub>1</sub>P<sub>2</sub> • V<sub>2</sub>P<sub>2</sub>
- V<sub>1</sub>P<sub>3</sub> • V<sub>2</sub>P<sub>3</sub>
- V<sub>1</sub>P<sub>4</sub> • V<sub>2</sub>P<sub>4</sub>
- V<sub>1</sub>P<sub>5</sub> • V<sub>2</sub>P<sub>5</sub>

### **3.5.2 Design and layout of the experiment**

The experiment was laid out in two factor Completely Randomized Design with three replications. The size of the individual pot was 0-15 cm depth and total numbers of pots were 30. There were 10 treatment combinations. Layout of the experiment was done on December, 2023 with inter pot spacing of 1 m.

### **3.6 Planting material**

The varieties of soybean used in this experiment was BARI Soyabean-5 and BARI Soybean-6. The seed of this variety was collected from Bangladesh Agriculture Research Institute, Bhola. These released varieties have excellent seed quality and superior to others.

### **3.7 Crop management**

#### **3.7.1 Preparation of the pot**

The experimental pots were first filled with soil on last week of November 2023. Potted soils was bought into desirable fine tilth by hand mixing. The stubble and weeds were removed from the soil and every pot was filled by 4 kg soil

#### **3.7.2 Fertilizer application**

Urea, Triple super phosphate (TSP), Muriate of potash (MoP), gypsum and boric acid were used as a source of nitrogen, phosphorous, potassium, sulphur, and boron respectively. The fertilizers urea, TSP, MoP, gypsum, boric acid were applied at the rate of 50-60 kg, 150-175 kg, 100-120 kg, 80-115 kg and 8-10 kg ha<sup>-1</sup> respectively following the Bangladesh Agricultural Research Institute (BARI) recommendation (BARI, 2011). All of the fertilizers were applied during the final pot preparation.

### **3.7.3 Seed treatment**

Before sowing the seeds were properly primed with organic leaf extract at different concentrations.

### **3.7.4 Sowing of seeds**

Sowing was done on 24 December 2023. Seeds were sown having a depth of 2-3 cm and total 20 seeds were placed in each pot.

### **3.8 Preparation of priming solution**

For preparation of 3% and 5% *Moringa* extract solution and 2% and 4% of *Aloe vera* leaf extract solution were separately dissolved 100 ml tap water, respectively. The seeds were treated with the calculated amount of priming solutions except control.

### **3.9 Intercultural operations**

After raising seedlings, various intercultural operations such as weeding, watering, pest and disease control etc. were accomplished for better growth and development of the soybean seedlings.

#### **3.9.1 Thinning**

At 15 DAS, excess plants were thinned out and maintained plant to plant distance 5 cm.

#### **3.9.2 Weeding**

The crop was weeded twice. First weeding was done at 25 days after sowing (DAS) and second weeding was done at 45 DAS.

#### **3.9.3 Irrigation**

Irrigation was done at 30 DAS after sowing (pre-flowering) stage and then at 60 DAS (pod formation stages) as per recommendation (BARI, 2011). Proper drainage system was also made for draining out excess water.

#### **3.9.4 Plant protections**

The soybean plants were infested by hairy caterpillars (*Dlaerisia oblique*) and cutworm at early growth stage which was controlled by applying Sumithion 50 EC @1.01 ha<sup>-1</sup>. On the other hand picking of infested leaves with caterpillar larvae was also done as a control measure. Diseased or off type plants were uprooted as and when required.

### **3.9.5 General observations of the experimental field**

Regular observations were made to see the growth stages of the crop. In general, the field looked nice with normal green plants which were vigorous and luxuriant in the treatment pots than that of control pots.

### **3.9.6 Sampling and data collection**

Five plants from each plot were randomly selected and marked with sample card. Plant height and number of branches plant<sup>-1</sup> were recorded from selected plants at an interval of 20 days started from 40 DAS to 60 DAS and at harvest

### **3.9.7 Harvesting and post-harvest operation**

Maturity of crop was determined when 95 % of the pods become brown in color. Five sample plants were collected from each pot before harvesting for taking yield attributes data. The plants of central 1 m<sup>2</sup> area were harvested by placing quadrates at random for recording yield data. Harvesting was done on 29 May, 2024. The harvested crops from each pot were tied up into bundles separately, tagged and brought to the clean threshing floor. The same procedure was followed for sample plants.

### **3.9.8 Threshing**

The crop bundles were sun dried for four days by spreading them on the threshing floor. Seeds were separated from the stover by hand machine and rubbing.

Drying Seeds and stover were cleaned and dried in the sun for four consecutive days.

After proper drying of seeds to a moisture content of 12 % were kept in polythene bags. Moisture contents were determined by moisture meter. 20

### **3.9.9 Cleaning and weighing**

Dried seeds and stover was weighed pot wise. After that the weights were averaged

### **3.10 Data collection**

The following data were collected

#### **A. Crop growth characters**

- i. Plant height at 20,40,60,80, DAS and at harvest
- ii. Number of branches plant<sup>-1</sup> 40 DAS to harvest

## **B. Yield contributing characters**

- i. Number of pods plant<sup>-1</sup>
- ii. Pod length (cm)
- iii. Number of seeds pod<sup>-1</sup>
- iv. Weight of 100-seed (g)
- v. Seed yield (g plant<sup>-1</sup>)
- vi. Stover yield (g plant<sup>-1</sup>)
- vii. Biological yield (g plant<sup>-1</sup>)
- viii. Harvest index (%)

### **3.11 Procedure of data collection**

#### **A. Crop growth characters**

##### **i. Plant height**

The height of the soybean plants was recorded at 20, 40, 60 DAS and at harvest. The heights of sample plants were measured from the ground level to the tip of the shoot. Five plants per pot were randomly selected and data was collected in CM.

##### **ii. Number of branches plant<sup>-1</sup>**

The total number of branches plant<sup>-1</sup> was counted from five selected plants per pot and counted at 40, 60 DAS and at harvest.

#### **B. Yield contributing characters**

##### **i. Number of pods plant<sup>-1</sup>**

Numbers of total pods of selected plants from each plot were counted and the mean numbers were expressed as plant<sup>-1</sup> basis.

##### **ii. Pod length**

Pod length was taken of randomly selected ten pods and the mean length was expressed on pod<sup>-1</sup> basis.

##### **iii. Number of seeds pod<sup>-1</sup>**

The number of seeds pods-1 was recorded from randomly selected 10 pods at the time of harvest. Data were recorded as the average of 10 pods from each pot.

**iv. Weight of 100- seeds**

One hundred cleaned, dried seeds were counted from each harvest sample and weighed by using a digital electric balance and weight was expressed in gram (g).

**v. Seed yield (g)**

The seeds collected from each pot were cleaned. The weight of seeds was taken and recorded in g pot<sup>-1</sup>.

**vi. Stover yield (g)**

The stover collected from each pot was sun dried properly. The weight of stover was taken and recorded in g pot<sup>-1</sup>.

**vii. Biological yield**

Biological yield was calculated by using the following formula: Biological yield= Seed yield + Straw yield

**viii. Harvest index (%)**

Harvest index is the relationship between seed yield and biological yield (Gardner *et al.*, 1985). It was calculated by using the following formula:

$$\text{HI (\%)} = \text{Seed yield/Biological yield} * 100.$$

### **3.12 Statistical analysis**

The data collected on different parameters were statistically analyzed to obtain the level of significance by using MSTAT-C computer package program. The significant differences among the treatment means were compared by LSD and Duncan's Multiple Range Test (DMRT) at 5% level of probability.

## CHAPTER IV

### RESULTS AND DISCUSSION

The research work was accomplished to investigate the effect of seed priming with controlled condition and different % of organic extract named *Moringa*, *Aloe vera* which enhance the germination capability of soybean varieties cv. BARI soybean 5 and BARI soybean 6 are discuss and present below. The results of the germination and growth parameters of soybean as influenced by different concentration of priming agents have been presented in this chapter. Some of the data have been presented and expressed in table and other in figures for easy discussion, comparison and understanding. The results of each parameter have been discussed and possible interpretations where ever necessary have been given under the following headings:

#### **4.1. Crop growth characters**

##### **4.1.1. Plant height**

###### **4.1.1.1. Effect of variety on plant height**

There was a significant variation on plant height at different growth stages influenced by different varieties of soybean. Plant height of soybean was varied significantly due to different soybean varieties at different days after sowing (DAS). Plant height gradually increased up to 60 DAS and thereafter at harvest respectively. It could be inferred from the figure that, V<sub>2</sub> (BARI Soybean 6) showed the tallest plant (12.85 cm, 28.25 cm, 44.54 cm and 51.91 cm) and V<sub>1</sub> (BARI Soybean 5) showed the shortest (11.61 cm, 27.31 cm, 42.37 cm and 49.14 cm) for sampling dates of 20 DAS, 40 DAS, 60 DAS and At Harvest, respectively which was also significantly different from the other variety followed by V<sub>2</sub>.

Table 1: Effect of variety on plant height of soybean at different DAS

Variety	20 DAS	40 DAS	60 DAS	At Harvest
V <sub>1</sub>	11.61 b	27.31 b	42.37 b	49.14 b
V <sub>2</sub>	12.85 a	28.25 a	44.54 a	51.91 a
LSD <sub>0.05</sub>	1.33	1.71	2.15	1.95
CV (%)	14.16	8.02	6.44	5.03
LS	*	*	*	**

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

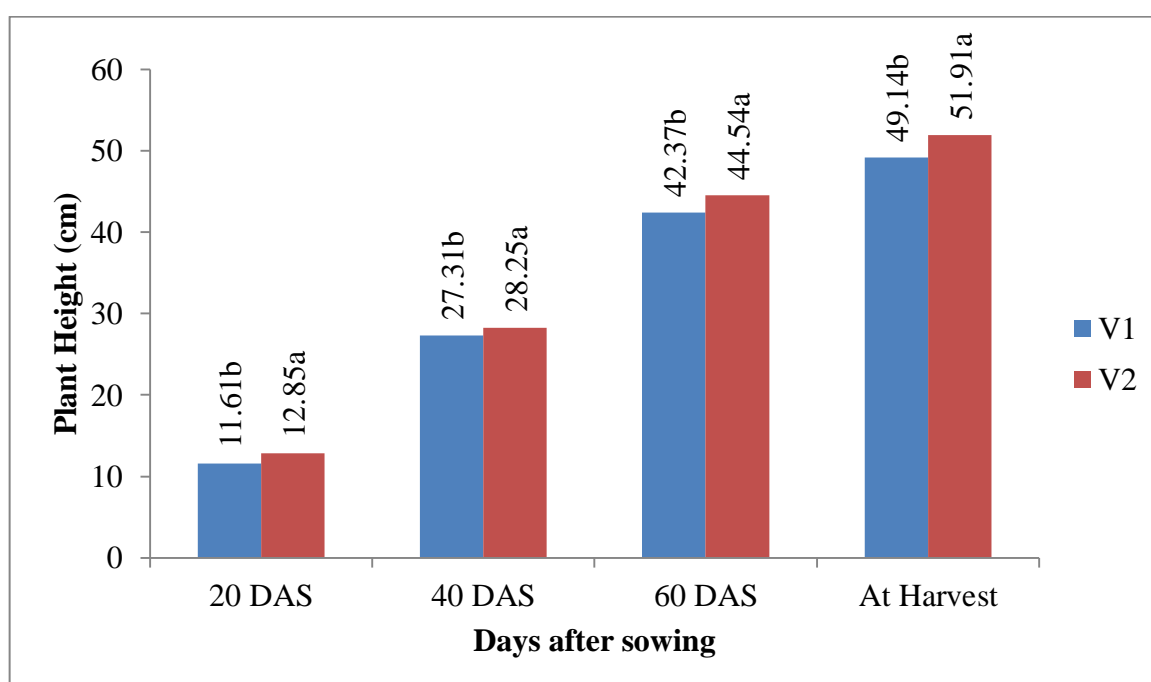
NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance



Legend: V<sub>1</sub>= BARI Soybean-5, V<sub>2</sub>= BARI Soybean-6

**Fig. 1: Effect of variety on plant height of soybean at different DAS**

#### 4.1.1.2. Effect of priming on plant height

Different seed priming treatments had significant influence on plant height of Soybean at different growth stages (Fig. 1 and Appendix IV). It was found that the highest plant height (14.30 cm, 32.32 cm, 46.27 cm and 56.05 cm at 20 DAS, 40 DAS, 60 DAS and at harvest, respectively) was found from the priming treatment, P<sub>3</sub> (seed priming with 6% *Moringa* leaf extract) which was statistically identical with P<sub>2</sub> (seed priming with 3% *Moringa* leaf extract), P<sub>5</sub> (seed priming with 4% *Aloe vera*) which was statistically identical with P<sub>4</sub> (seed priming with 2% *Aloe vera*) at 20 DAS, at 40 DAS, 60 DAS and at harvest. Similarly, the lowest plant height (12.30 cm, 21.32 cm, 37.70 cm and 42.18 cm at 20 DAS, 40 DAS, 60 DAS and at Harvest respectively) was found from the priming treatment, P<sub>1</sub> (seed without priming) which was also significantly different from all other treatments

Table 2: Effect of priming concentrations on Plant Height of soybean at different DAS

Priming	20 DAS	40 DAS	60 DAS	At Harvest
P <sub>1</sub>	12.30 ab	21.32 c	37.70 b	42.18 d
P <sub>2</sub>	11.82 b	27.38 b	46.27 a	51.83 bc
P <sub>3</sub>	14.30 a	32.32 a	46.77 a	56.05 a
P <sub>4</sub>	10.78 b	26.75 b	40.92 b	48.77 c
P <sub>5</sub>	11.95 b	31.12 a	45.62 a	53.78 ab
LSD <sub>0.05</sub>	2.10	2.70	3.39	3.09
CV (%)	14.16	8.02	6.44	5.03
LS	*	**	**	**

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% *Aloe vera*

P<sub>5</sub>= 4% *Aloe vera*

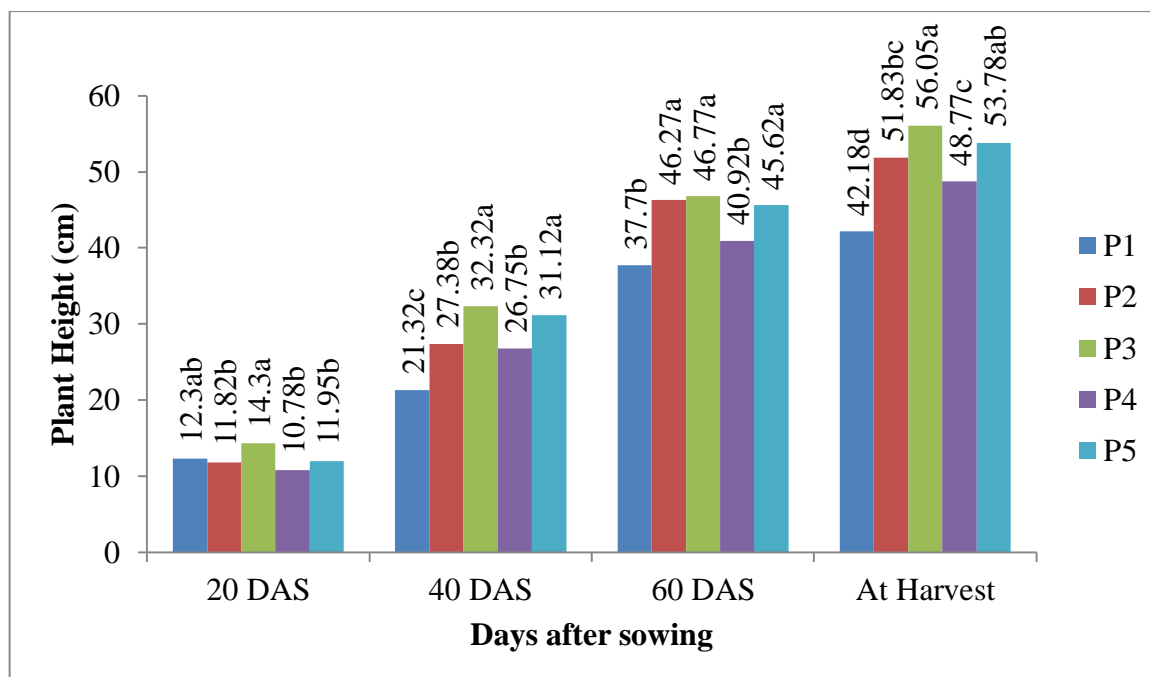
NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance



Legend: P<sub>1</sub>= Control (Without Priming), P<sub>2</sub>= 3% *Moringa*, P<sub>3</sub>= 6% *Moringa*, P<sub>4</sub>= 2% Aloe vera, P<sub>5</sub>= 4% Aloe vera

**Fig. 2: Effect of priming concentrations on plant height of soybean at different DAS**

#### 4.1.1.3. Interaction effect of variety and seed priming on plant height

Remarkable variation was observed on plant height at different growth stages influenced by interaction effect of variety and seed priming treatments (Table 3 and Appendix IV). Results indicated that the highest plant height (14.33 cm, 32.03 cm, 46.90 cm and 57.47 cm at 20 DAS, 40 DAS, 60 DAS and at Harvest, respectively) was found from the treatment combination of V<sub>2</sub>P<sub>3</sub> which was significantly different from all other treatments followed by V<sub>1</sub>P<sub>3</sub>, V<sub>1</sub>P<sub>5</sub> and V<sub>2</sub>P<sub>5</sub>. The lowest plant height (11.33cm, 21.20cm, 34.03, 41.25 at 20, 40, 60 DAS and at harvest) combination of V<sub>1</sub>P<sub>1</sub> which was significantly different from all other treatments at all growth stages followed by V<sub>1</sub>P<sub>1</sub>.

Table 3. Interaction effect of variety and seed priming on plant height of soybean at different DAS

Treatment combination	20 DAS	40 DAS	60 DAS	At Harvest
V <sub>1</sub> P <sub>1</sub>	11.33 bcd	21.20 d	34.03 d	41.25 f
V <sub>1</sub> P <sub>2</sub>	11.27 cd	26.90 bc	44.23 abc	50.53 cd
V <sub>1</sub> P <sub>3</sub>	14.27 ab	32.60 a	46.63 a	54.63 abc
V <sub>1</sub> P <sub>4</sub>	10.27 d	25.73 c	41.37 bc	46.90 de
V <sub>1</sub> P <sub>5</sub>	10.93 cd	30.10 ab	45.57 ab	52.37 bc
V <sub>2</sub> P <sub>1</sub>	13.27 abc	21.43 d	41.37 bc	43.10 ef
V <sub>2</sub> P <sub>2</sub>	12.37 abcd	27.87 bc	48.30 a	53.13 abc
V <sub>2</sub> P <sub>3</sub>	14.33 a	32.03 a	46.90 a	57.47 a
V <sub>2</sub> P <sub>4</sub>	11.30 bcd	27.77 bc	40.47 c	50.63 cd
V <sub>2</sub> P <sub>5</sub>	12.97 abcd	32.13 a	45.67 ab	55.20 ab
LSD <sub>0.05</sub>	2.97	3.82	4.80	4.36
CV (%)	14.16	8.02	6.44	5.03
LS	*	*	*	NS

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% Aloe vera

P<sub>5</sub>= 4% Aloe vera

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance

## 4.1.2. Number of branch plant<sup>-1</sup>

### 4.1.2.1. Effect of variety on number of branch plant<sup>-1</sup>

Number of branches plant<sup>-1</sup> of soybean varied significantly with different varieties at different growth stages (Table 4 and Appendix V). However, it was found that the highest number of branches plant<sup>-1</sup> (3.37, 3.96 and 4.61 at 40 DAS, 60 DAS and at harvest, respectively) was found from the variety which was statistically identical with another variety at 40, 60DAS and at harvest. The lowest number of branches plant<sup>-1</sup> (3.22 cm, 3.91 cm and 4.49 cm at 40 DAS, 60 DAS and at harvest, respectively) was found from the variety, V<sub>2</sub> which was statistically identical with V<sub>1</sub> at 40 DAS and 60 DAS.

Table 4: Effect of variety on number of branch plant<sup>-1</sup> of soybean at different DAS

Variety	40 DAS	60 DAS	At Harvest
V <sub>1</sub>	3.22	3.96	4.61
V <sub>2</sub>	3.37	3.91	4.49
LSD <sub>0.05</sub>	0.28	0.27	0.48
CV (%)	10.99	9.07	13.77
LS	NS	NS	NS

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

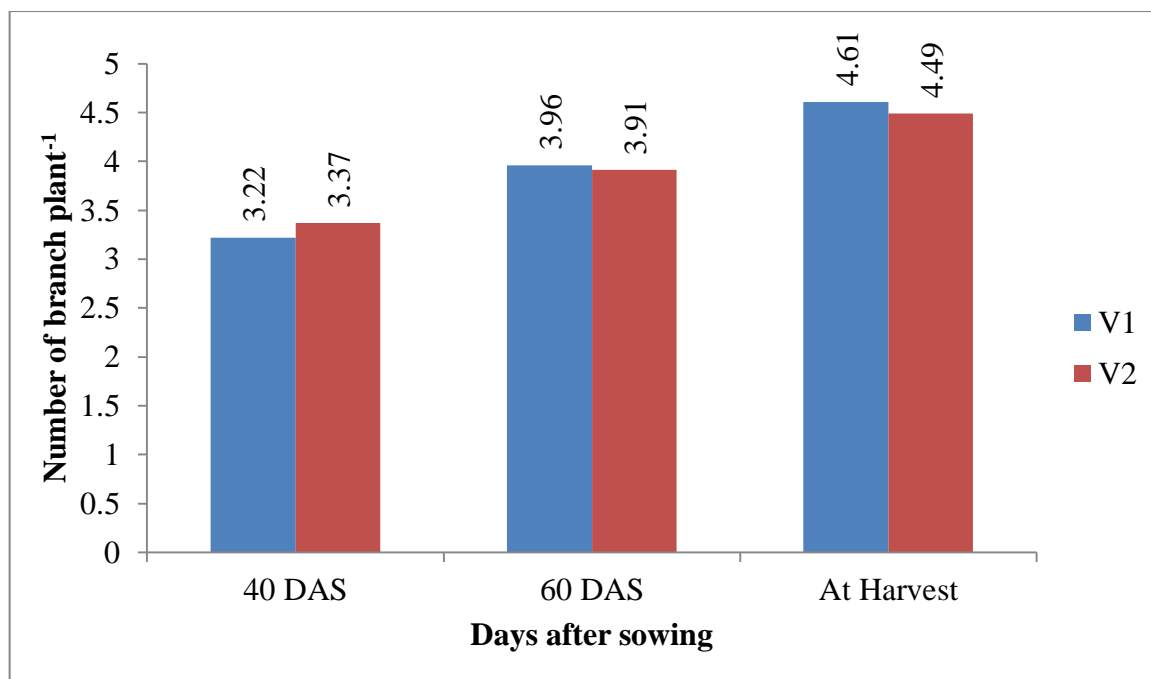
NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance



Legend: V<sub>1</sub>= BARI Soybean-5, V<sub>2</sub>= BARI Soybean-6

**Fig. 3: Effect of variety on number of branch plant<sup>-1</sup> of soybean at different DAS**

#### 4.1.2.2. Effect of seed priming on number of branch plant<sup>-1</sup>

The pronounced effect was observed on number of branches plant<sup>-1</sup> at different growth stages influenced by different seed priming treatments (Table 5 and Appendix V). Results signified that the highest number of branches plant<sup>-1</sup> (3.62, 4.58 and 5.43 at 40 DAS, 60 DAS and at harvest, respectively) was found from the priming treatment, P<sub>3</sub> (seed priming with 6% *Moringa* leaf extract) which was significantly different from all other treatments where the lowest number of branches plant<sup>-1</sup> (2.75, 3.27 and 3.78 at 40 DAS, 60DAS and at harvest, respectively) was found from the priming treatment, P<sub>1</sub> (seed priming with water) which was also significantly different from all other treatments. Saleem *et al.* (2014) also found similar result with the present study.

Table 5: Effect of priming on number of branch plant<sup>-1</sup> of soybean at different DAS

Priming	40 DAS	60 DAS	At Harvest
P <sub>1</sub>	2.75 b	3.27 d	3.78 c
P <sub>2</sub>	3.35 a	4.02 bc	4.77 ab
P <sub>3</sub>	3.62 a	4.58 a	5.43 a
P <sub>4</sub>	3.35 a	3.68 cd	4.23 bc
P <sub>5</sub>	3.42 a	4.13 b	4.53 bc
LSD <sub>0.05</sub>	0.44	0.43	0.76
CV (%)	10.99	9.07	13.77
LS	**	**	**

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% Aloe vera

P<sub>5</sub>= 4% Aloe vera

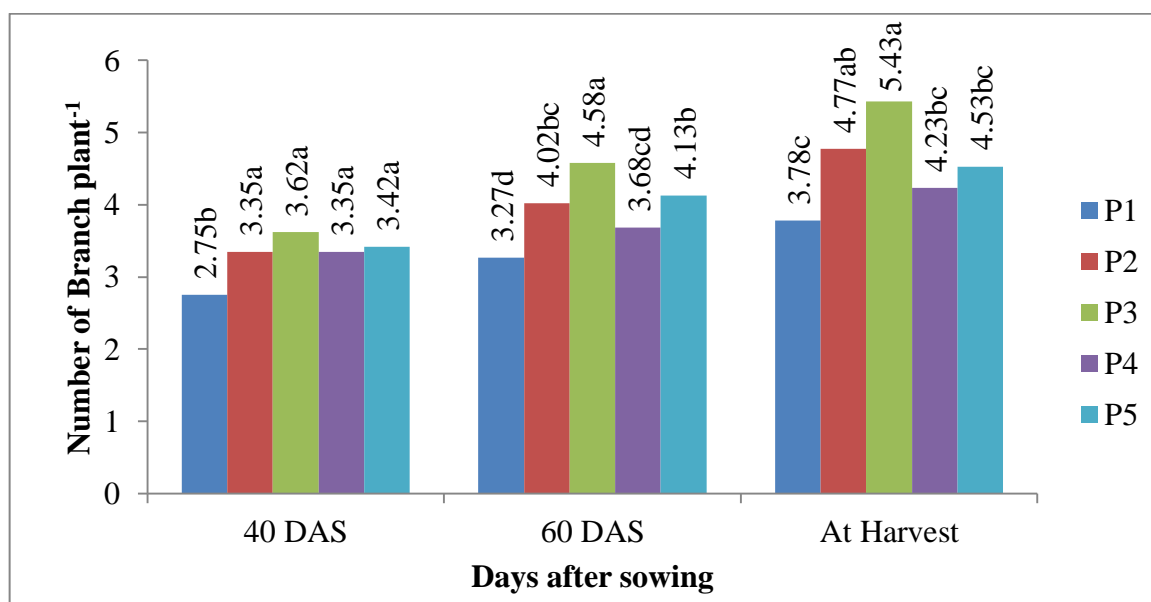
NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance



Legend: P<sub>1</sub>= Control (Without Priming), P<sub>2</sub>= 3% *Moringa*, P<sub>3</sub>= 6% *Moringa*, P<sub>4</sub>= 2% Aloe vera, P<sub>5</sub>= 4% Aloe vera

Fig. 4: Effect of priming on number of branch plant<sup>-1</sup> of soybean at different DAS

#### **4.1.2.3. Interaction effect of variety and seed priming on number of branch plant<sup>-1</sup>**

Number of branches plant<sup>-1</sup> was significantly varied due to interaction effect of variety and seed priming treatments at different growth stages (Table 6 and Appendix V). It was noted that the highest number of branches plant<sup>-1</sup> (3.70, 4.63 and 5.43 at 40 DAS, 60 DAS and at harvest, respectively) was found from the treatment combination of V<sub>2</sub>P<sub>3</sub> which was statistically identical with V<sub>1</sub>P<sub>3</sub>, V<sub>1</sub>P<sub>5</sub>, V<sub>1</sub>P<sub>2</sub>, V<sub>2</sub>P<sub>4</sub> and V<sub>2</sub>P<sub>5</sub> followed by all growth stages. And also, statistically identical with V<sub>2</sub>P<sub>3</sub> at 60 DAS and at harvest but at 40 DAS it was significantly different from all other treatments followed by V<sub>2</sub>P<sub>1</sub>, V<sub>2</sub>P<sub>2</sub> and V<sub>2</sub>P<sub>4</sub>. The lowest number of branches plant<sup>-1</sup> (2.63, 3.30 and 3.70 at 40 DAS, 60 DAS and at harvest, respectively) was found from the treatment combination of V<sub>1</sub>P<sub>1</sub> which was statistically identical with V<sub>2</sub>P<sub>1</sub> at 40 DAS growth stages and at harvest it was significantly different from all other treatments.

Table 6. Interaction effect of variety and priming concentrations on number of branches plant<sup>-1</sup> of soybean at different DAS

Treatment combination	40 DAS	60 DAS	At Harvest
V <sub>1</sub> P <sub>1</sub>	2.63 c	3.30 d	3.70 c
V <sub>1</sub> P <sub>2</sub>	3.27 ab	4.10 abc	5.07 ab
V <sub>1</sub> P <sub>3</sub>	3.53 a	4.53 ab	5.43 a
V <sub>1</sub> P <sub>4</sub>	3.37 ab	3.73 cd	4.27 bc
V <sub>1</sub> P <sub>5</sub>	3.30 ab	4.13 abc	4.57 abc
V <sub>2</sub> P <sub>1</sub>	2.87 bc	3.23 d	3.87 c
V <sub>2</sub> P <sub>2</sub>	3.43 ab	3.93 bc	4.47 abc
V <sub>2</sub> P <sub>3</sub>	3.70 a	4.63 a	5.43 a
V <sub>2</sub> P <sub>4</sub>	3.33 ab	3.63 cd	4.20 bc
V <sub>2</sub> P <sub>5</sub>	3.53 a	4.13 abc	4.50 abc
LSD <sub>0.05</sub>	0.62	0.61	1.07
CV (%)	10.99	9.07	13.77
LS	*	*	*

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% Aloe vera

P<sub>5</sub>= 4% Aloe vera

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance

## **4.2. Yield contributing characters on variety**

### **4.2.1. Pod length**

There was a significant variation on pod length at harvesting stages influenced by different varieties of soybean. The pod length of soybean was varied significantly due to different soybean varieties was found after the harvesting stages. It could be inferred from the figure that, V<sub>2</sub> (BARI Soybean 6) showed the longest pod (3.01 cm,) and V<sub>1</sub> (BARI Soybean 5) showed the shortest (2.87cm) for sampling dates. At Harvest, respectively which was also significantly different from the other variety followed by V<sub>2</sub>.

### **4.2.2. Number of pods plant<sup>-1</sup>**

The number of pods plant<sup>-1</sup> of soybean was significantly affected by different varieties which was shown in the table 7 and appendix (VI) from the configuration of the table the highest number of pod plant<sup>-1</sup> (31.68) was found in V<sub>2</sub> (BARI Soybean 6) and the lowest number of pods plant<sup>-1</sup> was found in V<sub>1</sub> (BARI Soybean 5).

### **4.2.3. Seed pod<sup>-1</sup>**

Grain wt-1 plant of soybean crop had a significant effect with different varieties of soybean from the configuration of the table, the highest grain pod<sup>-1</sup> was found in V<sub>2</sub> (BARI Soybean 6) and lowest grain pod<sup>-1</sup> was shown in V<sub>1</sub> (BARI Soybean 5) that was statistically significant with other variety.

### **4.2.4. 100-seed weight**

100 seed weight of crop had significant effect with different varieties of soybean after harvesting stages. The highest 100 seed weight (8.43) was observed for the V<sub>2</sub> (BARI Soybean 6) and the lowest 100 seed weight was found in V<sub>1</sub> (BARI Soybean5) that was statistically significant with the other variety.

Table 7: Effect of variety on pod length, number of pod plant<sup>-1</sup>, seed pod<sup>-1</sup> and 100-seed weight

Variety	Pod length (cm)	Number of pod plant <sup>-1</sup>	Seed pod <sup>-1</sup>	100-seed weight
V <sub>1</sub>	2.87 a	28.81 b	2.37 b	7.64 b
V <sub>2</sub>	3.01 a	31.68 a	2.56 a	8.43 a
LSD <sub>0.05</sub>	0.26	3.65	0.18	0.77
CV (%)	11.48	9.73	9.45	12.51
LS	NS	*	*	*

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance

### 4.3. Yield contributing characters on seed priming

#### 4.3.1. Pod length

Pod length of Soybean was significantly affected by the different concentrations of the priming agents was found after the harvesting stages. The length of the pod significantly increased with the increasing concentrations of different priming agents. However, the highest pod length(3.39) was observed for the primig agent (6% *Moringa*) under P<sub>3</sub> priming treatment and the lowest pod length (2.36 cm) was found in the controlled condition belongs P<sub>1</sub> Treatment(without priming).P<sub>5</sub> treatment (4% *Aloevera*) was statistically significant with the P<sub>4</sub> treatment(2%*Aloevera*) that configuration was shown in the table 8.

#### **4.3.2. Number of pods plant<sup>-1</sup>**

The number of pods plant<sup>-1</sup> of soybean was significantly influenced by the different concentrations of priming solutions at harvesting stages (Table 8). The number of pods plant<sup>-1</sup> was significantly increased with increasing concentrations of priming agents. The highest number of pods plant<sup>-1</sup> was found in P<sub>3</sub> treatment (6% *Moringa*) was (38.23) and the lowest number of pods plant<sup>-1</sup> observed at P<sub>1</sub> treatment (without priming) was (23.28). This result is in agreement with the findings of EI- Sabagh *et al.* (2015) who reported that organic priming remarkably increased the number of pods plant<sup>-1</sup> in priming solutions.

#### **4.3.3. Seed pod<sup>-1</sup>**

Number of grain pod<sup>-1</sup> of soybean varied significantly due to the different levels of priming solution at harvesting stages .it could be observed from the figure that P<sub>3</sub> priming treatment(6% *Moringa*) showed the maximum grain pod<sup>-1</sup> (2.87)and P<sub>1</sub> treatment(without priming) showed the minimum grain pod<sup>-1</sup> (1.99) in the table 8. These results are supported by several studies reporting that application of priming solutions increased the seed yields (Saeed *et al.*, 2016, Uddin, 2017; Jibril, 2017).

#### **4.3.4. 100-seed weight**

100-seed weight had significant effect on different % concentration of organic priming agent (Table 8). The highest weight (9.75g) was observed in P<sub>3</sub> priming treatment and the P<sub>1</sub> priming treatment resulted the minimum 100 seed weight (6.33g). The result is close in arrangement with findings of Uddin (2017) who reported that organic priming significantly increased the 100-seed weight. The positive effect of organic compost on the 100 seed weight was reported by EI-Sabagh *et al.* (2015). This might be the fact that nitrogen composes protoplasmic protein, which required for increasing the 100-seed weight. Similar result was reported by Awad (2004). Hirich *et al.* (2014) reported that organic compost and organic priming significantly influenced the weight of 100 grains of quinoa and pea.

Table 8: Effect of priming on pod length, number of pod plant<sup>-1</sup>, seed pod<sup>-1</sup> and 100-seed weight

Priming	Pod length (cm)	Number of pod plant <sup>-1</sup>	Seed pod <sup>-1</sup>	100-seed weight
P <sub>1</sub>	2.36 b	23.28 c	1.99 c	6.33 c
P <sub>2</sub>	3.24 a	30.47 b	2.44 b	7.98 b
P <sub>3</sub>	3.39 a	38.23 a	2.87 a	9.75 a
P <sub>4</sub>	2.63 b	27.03 bc	2.39 b	7.63 b
P <sub>5</sub>	3.09 a	32.22 b	2.62 ab	8.48 b
LSD <sub>0.05</sub>	0.41	5.77	0.28	1.22
CV (%)	11.48	9.73	9.45	12.51
LS	**	**	**	**

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% Aloe vera

P<sub>5</sub>= 4% Aloe vera

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance

#### **4.4. Yield contributing characters on interaction effect of variety and seed priming**

##### **4.4.1. Pod length (cm)**

Interaction effect different treatment of organic leaf extract solutions had significant effect on pod length of soybean (Table 9 and Appendix VI). The maximum pod length of soybean (3.46 g plant<sup>-1</sup>) was recorded from V<sub>3</sub>P<sub>2</sub> treatment combination whereas the lowest pod length produce (2.24 g plant<sup>-1</sup>) from V<sub>2</sub>P<sub>1</sub> combination.

##### **4.4.2. Number of pods plant<sup>-1</sup> (no.)**

Interaction effect different treatment of organic leaf extract solutions had significant effect on number of pods plant<sup>-1</sup> of soybean (Table 9 and Appendix VI). The maximum number of pods plant<sup>-1</sup> of soybean (40.53 g plant<sup>-1</sup>) was recorded from V<sub>3</sub>P<sub>2</sub> treatment combination whereas the lowest number of pods plant<sup>-1</sup> produce (22.13 g plant<sup>-1</sup>) from V<sub>1</sub>P<sub>1</sub> combination.

##### **4.4.3. Seed pod<sup>-1</sup> (no.)**

Interaction effect different treatment of organic leaf extract solutions had significant effect on Grain pod<sup>-1</sup> of soybean (Table 9 and Appendix VI). The maximum grain pod<sup>-1</sup> of soybean (3.05 g plant<sup>-1</sup>) was recorded from V<sub>3</sub>P<sub>2</sub> treatment combination whereas the lowest grain pod<sup>-1</sup> produce (1.96 g plant<sup>-1</sup>) from V<sub>1</sub>P<sub>1</sub> combination.

##### **4.4.4. 100-seed weight (g)**

Interaction effect different treatment of organic leaf extract solutions had significant effect on 100-seed weight of soybean (Table 9 and Appendix VI). The maximum 100-seed weight of soybean (9.77 g plant<sup>-1</sup>) was recorded from V<sub>3</sub>P<sub>2</sub> treatment combination whereas the lowest 100-seed weight produce (5.33 g plant<sup>-1</sup>) from V<sub>1</sub>P<sub>1</sub> combination.

Table 9. Interaction effect of variety and priming on pod length, number of pod plant<sup>-1</sup>, 100-seed weight

Treatment combination	Pod length	Number of pod plant <sup>-1</sup>	Seed pod <sup>-1</sup>	100-seed weight
V <sub>1</sub> P <sub>1</sub>	2.48 bc	22.13 d	1.96 c	5.33 c
V <sub>1</sub> P <sub>2</sub>	3.20 a	31.07 bc	2.33 bc	7.17 b
V <sub>1</sub> P <sub>3</sub>	3.31 a	35.93 ab	2.70 ab	9.73 a
V <sub>1</sub> P <sub>4</sub>	2.34 c	24.03 cd	2.32 bc	7.60 b
V <sub>1</sub> P <sub>5</sub>	3.04 ab	30.90 bc	2.54 b	8.37 ab
V <sub>2</sub> P <sub>1</sub>	2.24 c	24.43 cd	2.02 c	7.33 b
V <sub>2</sub> P <sub>2</sub>	3.27 a	29.87 bcd	2.54 b	8.80 ab
V <sub>2</sub> P <sub>3</sub>	3.46 a	40.53 a	3.05 a	9.77 a
V <sub>2</sub> P <sub>4</sub>	2.93 ab	30.03 bcd	2.47 b	7.67 b
V <sub>2</sub> P <sub>5</sub>	3.15 a	33.53 ab	2.70 ab	8.60 ab
LSD <sub>0.05</sub>	0.58	8.16	0.40	1.72
CV (%)	11.48	9.73	9.45	12.51
LS	*	*	*	*

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% Aloe vera

P<sub>5</sub>= 4% Aloe vera

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

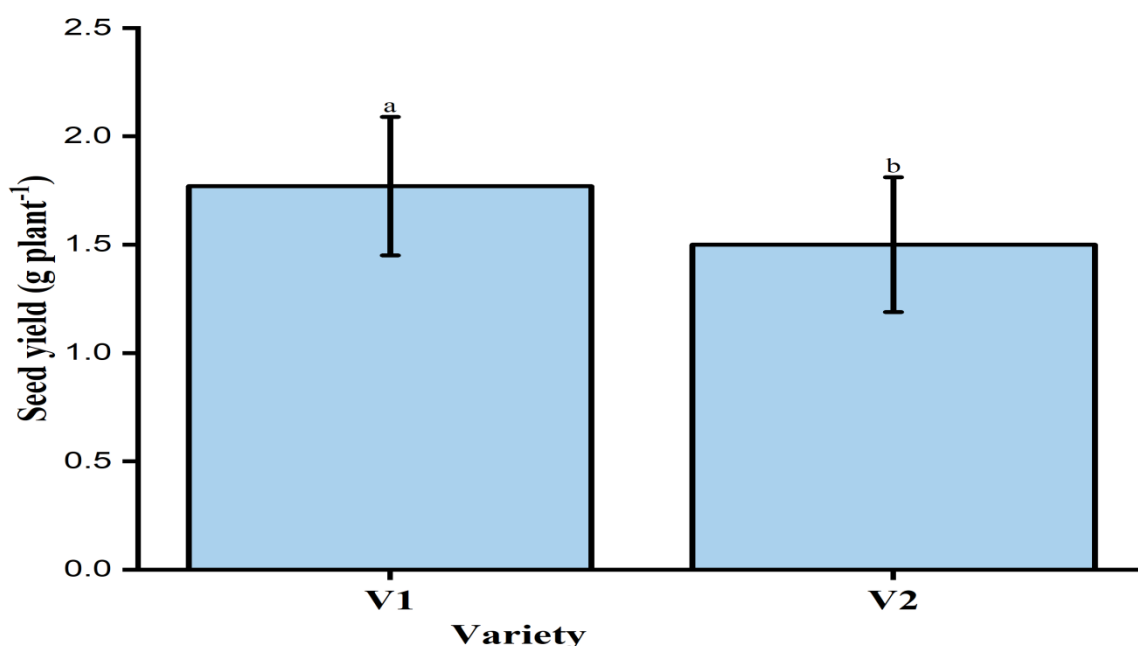
LS=Level of Significance

CV=Coefficient of variance

#### 4.5. Effect of variety on seed yield, stover yield, biological yield and harvest index

##### 4.5.1. Seed yield ( $\text{g plant}^{-1}$ )

Yield of soybean varied significantly with different concentrations of organic seed priming (Table 10 and Appendix VII). The maximum seed yield of soybean ( $1.77 \text{ g plant}^{-1}$ ) was recorded from BARI Soybean-6 ( $V_2$ ) treatment whereas, the minimum ( $1.51 \text{ g plant}^{-1}$ ) was recorded from BARI Soybean-5 ( $V_1$ ). Organic priming increased seed yield over control. Yield obviously is the ultimate goal in growing any crop. Thus, the economic importance of plant growth regulators is their ability to increase crop yields. Kumar *et al.* (1999) reported that the foliar application of hormonal treatment to soybean enhanced yield. Similar results were recorded with Salicylic acid by Hayat *et al.* (2005). It was reported that salicylic acid application promotes cell division and cell enlargement.



Legend:  $V_1$ = BARI Soybean-5,  $V_2$ = BARI Soybean-6

**Fig. 5: Effect of variety on seed yield of soybean**

The increase in seed yield may be due to increase in the number of pod per plant and stimulant effect on chlorophyll content in soybean leaves as well as increased activity of antioxidant enzyme and reduced oxidative damage which reflects with lower MDA production due to treatment effect of SA. Photosynthetic pigments such as chlorophyll a and b are chief components of photo system driving the mechanism of photosynthesis and hence growth in terms of biomass production or seed yield (Hussein *et al.* 2007).

Similar result was also found by Khatun *et al.* (2016) when SA improved soybean genotypes tolerance to water stress by limited lipid per oxidation, promote antioxidant enzymes activity and improvement yield components and seed yield particularly in Williams's genotype.

#### **4.5.2. Stover yield (g plant<sup>-1</sup>)**

Stover yield of soybean showed significant effect on variety (Table 10 and Appendix VII). Numerically the maximum Stover yield of soybean (3.56 g plant<sup>-1</sup>) was recorded from V<sub>2</sub> treatment, the minimum (3.36 g plant<sup>-1</sup>) was recorded from V<sub>1</sub> treatment. Similar result was also found by Khatun *et al.* (2016).

#### **4.5.3. Biological yield (g plant<sup>-1</sup>)**

Biological yield of soybean had significant effect on different variety of soybean (Table 10 and Appendix VII). Numerically the maximum biological yield of soybean (5.33 g plant<sup>-1</sup>) was recorded from V<sub>2</sub>, the minimum (4.87 g plant<sup>-1</sup>) was recorded from V<sub>1</sub>. Copur *et al.* (2010) assessed significantly biological yield was recorded in all the concentrations of NAA followed by GA<sub>3</sub> and Kinetin.

#### **4.5.4. Harvest index (%)**

Harvest index of soybean had significant effect on different varieties on soybean (Table 10 and Appendix VII). The maximum harvest index of soybean (33.02 %) was recorded from V<sub>2</sub> treatment which was statistically similar to V<sub>2</sub> whereas, the minimum (30.67 %) was recorded from V<sub>1</sub>. Organic priming increased harvest index over control. Harvest index was increased due to spraying the plants with plant growth regulators as compared to control. Similar result was also found by Khatun *et al.* (2016).

Table 10. Effect of variety on seed yield, stover yield, biological yield and 100 harvest index

Variety	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
V <sub>1</sub>	1.51 b	3.36 b	4.87 b	30.67 b
V <sub>2</sub>	1.77 a	3.56 a	5.33 a	33.02 a
LSD <sub>0.05</sub>	0.15	0.29	0.17	1.44
CV (%)	11.73	7.38	6.49	5.90
LS	**	**	*	**

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

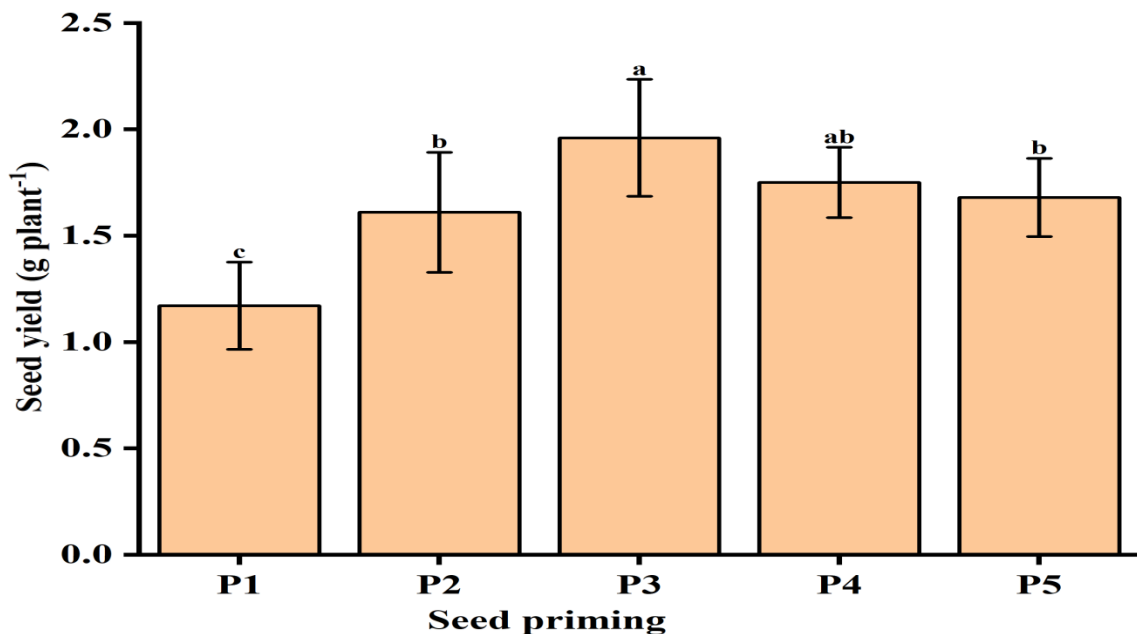
LS=Level of Significance

CV=Coefficient of variance

#### 4.6. Effect of priming on seed yield, stover yield, biological yield and harvest index

##### 4.6.1. Seed yield (g plant<sup>-1</sup>)

Different time of application also influenced significantly the yield of soybean (Table 11 and Appendix VII). The minimum yield of soybean (1.17 g plant<sup>-1</sup>) was obtained from P<sub>1</sub> treatment while, the maximum (1.96 g plant<sup>-1</sup>) was obtained from P<sub>3</sub> treatment. Devi *et al.* (2011) observed that yield of soybean increased with different organic priming effect at flower+ pod initiation stage. These findings also correlate the above mentioned findings. The increased yield might be due to enhanced yield attributes like number of pods plant<sup>-1</sup>, number of seeds pod<sup>-1</sup> due to increased uptake of plant growth regulators by soybean by effective translocation of plant growth regulators from sink to reproductive area of crop.



Legend: P<sub>1</sub>= Control (Without Priming), P<sub>2</sub>= 3% *Moringa*, P<sub>3</sub>= 6% *Moringa*, P<sub>4</sub>= 2% *Aloe vera*, P<sub>5</sub>= 4% *Aloe vera*

**Fig. 6: Effect of priming on seed yield of soybean**

##### 4.6.2. Stover yield (g plant<sup>-1</sup>)

Different organic priming treatments also influenced significantly the Stover yield of soybean (Table 11 and Appendix VII). The maximum stover yield of soybean (3.63 g plant<sup>-1</sup>) was obtained from P<sub>4</sub> (4% *Aloevera*) treatment which was statistically significant treatment and while the minimum (3.05 g plant<sup>-1</sup>) was obtained from P<sub>1</sub> (Without Priming). Similar result was also found by Khatun *et al.* (2016).

#### 4.6.3. Biological yield (g plant<sup>-1</sup>)

Different organic priming had significant effects on the biological yield of soybean (Table 11 and Appendix VII). Numerically the maximum biological yield of soybean (5.57 g plant<sup>-1</sup>) was obtained from P<sub>3</sub> which was statistically similar to P<sub>2</sub>, P<sub>3</sub> and P<sub>5</sub> whereas, the minimum (4.22 g plant<sup>-1</sup>) was recorded from P<sub>1</sub>. Similar result was also found by Khatun *et al.* (2016).

#### 4.6.4. Harvest index (%)

Different organic priming solution also influenced significantly the harvest index of soybean (Table 11 and Appendix VII). The maximum harvest index of soybean (35.18 %) was obtained from P<sub>3</sub> and the minimum (27.68 %) harvest index was recorded in P<sub>1</sub>.

Table 11. Effect of priming on seed yield, stover yield, biological yield and harvest index

Priming	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
P <sub>1</sub>	1.17 c	3.05 b	4.22 c	27.68 c
P <sub>2</sub>	1.61 b	3.43 a	5.05 b	31.89 b
P <sub>3</sub>	1.96 a	3.60 a	5.57 a	35.18 a
P <sub>4</sub>	1.69 b	3.63 a	5.32 ab	31.67 b
P <sub>5</sub>	1.76 ab	3.59 a	5.35 ab	32.79 b
LSD <sub>0.05</sub>	0.23	0.27	0.46	2.28
CV (%)	11.73	6.49	7.38	5.90
LS	**	**	**	**

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% *Aloe vera*

P<sub>5</sub>= 4% *Aloe vera*

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

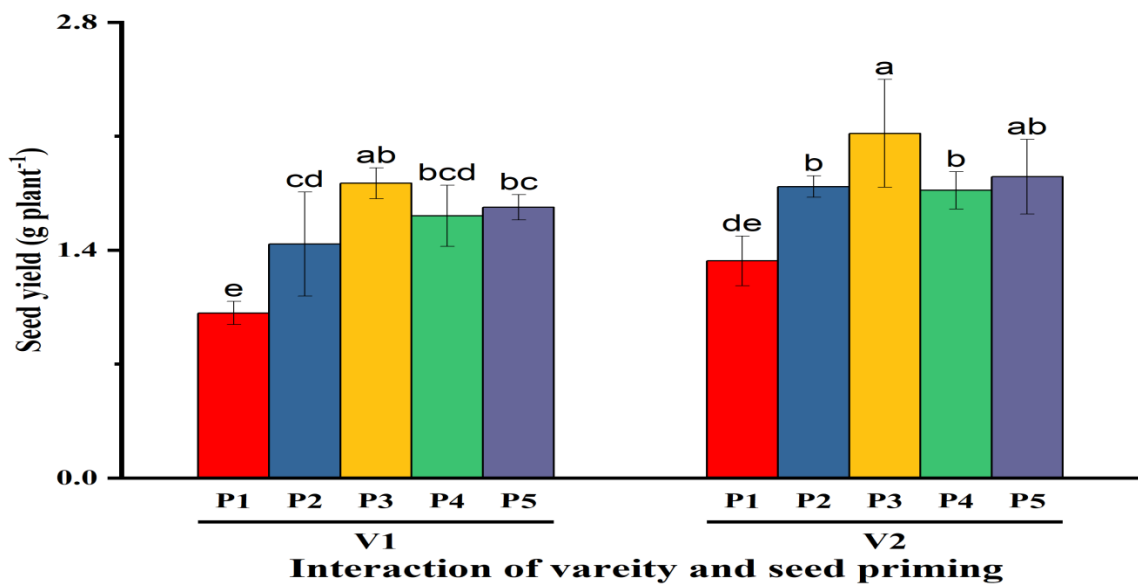
LS=Level of Significance

CV=Coefficient of variance

#### 4.7. Interaction effect of variety and priming on seed yield, stover yield, biological yield and harvest index

##### 4.7.1. Seed yield (g plant<sup>-1</sup>)

Interaction effect of different variety and priming of different organic treatment had significant effect on seed yield of soybean (Table 12 and Appendix VII). Numerically the maximum yield of soybean (2.12 g plant<sup>-1</sup>) was recorded from V<sub>2</sub>P<sub>3</sub> treatment combination whereas, the minimum (1.01 g plant<sup>-1</sup>) was recorded from V<sub>1</sub>P<sub>1</sub> treatment combination. Similar result was also found by Khatun *et al.* (2016)



Legend: V<sub>1</sub>= BARI Soybean-5, V<sub>2</sub>= BARI Soybean-6, P<sub>1</sub>= Control (Without Priming), P<sub>2</sub>= 3% Moringa, P<sub>3</sub>= 6% Moringa, P<sub>4</sub>= 2% Aloe vera, P<sub>5</sub>= 4% Aloe vera

**Fig. 7: Interaction of variety and seed priming of soybean**

##### 4.7.2. Stover yield (g plant<sup>-1</sup>)

Interaction effect different treatment of organic leaf extract solutions had significant effect on yield of soybean (Table 10 and Appendix VII). The maximum Stover yield of soybean (3.75 g plant<sup>-1</sup>) was recorded from V<sub>2</sub>P<sub>4</sub> treatment combination whereas the lowest stover yield produce (3.00 g plant<sup>-1</sup>) from V<sub>1</sub>P<sub>1</sub> combination.

##### 4.7.3. Biological yield (g plant<sup>-1</sup>)

Interaction effect of different organic priming and variety of soybean had significant effect on biological yield of soybean (Table 12 and Appendix VII). The maximum biological yield of soybean (5.80 g plant<sup>-1</sup>) was observed from V<sub>2</sub>P<sub>3</sub> treatment

combination which was statistically significant whereas minimum (3.00 g pot<sup>-1</sup>) was observed from V<sub>1</sub>P<sub>1</sub> combination. Similar result was also found by Khatun *et al.* (2016).

#### 4.7.4. Harvest index (%)

Interaction effect of variety and different organic priming had significant effect on harvest index of soybean (Table 12 and Appendix VII). The maximum harvest index of soybean (36.39 %) was observed from V<sub>2</sub>P<sub>3</sub> treatment combination whereas, the minimum (25.31 %) was observed from V<sub>1</sub>P<sub>1</sub> treatment combination.

Table 12. Interaction effect of variety and priming on seed yield, stover yield, biological yield and harvest index

Treatment combination	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
V <sub>1</sub> P <sub>1</sub>	1.01 e	3.00 d	4.01 e	25.31 d
V <sub>1</sub> P <sub>2</sub>	1.44 cd	3.32 bcd	4.76 cd	30.22 c
V <sub>1</sub> P <sub>3</sub>	1.81 ab	3.52 ab	5.33 abc	33.97 ab
V <sub>1</sub> P <sub>4</sub>	1.61 bcd	3.52 ab	5.13 bc	31.34 bc
V <sub>1</sub> P <sub>5</sub>	1.66 bc	3.46 abc	5.12 bc	32.50 bc
V <sub>2</sub> P <sub>1</sub>	1.33 de	3.10 cd	4.43 de	30.05 c
V <sub>2</sub> P <sub>2</sub>	1.79 ab	3.54 ab	5.33 abc	33.56 ab
V <sub>2</sub> P <sub>3</sub>	2.12 a	3.68 ab	5.80 a	36.39 a
V <sub>2</sub> P <sub>4</sub>	1.77 b	3.75 a	5.52 ab	32.00 bc
V <sub>2</sub> P <sub>5</sub>	1.85 ab	3.73 a	5.58 ab	33.09 bc
LSD <sub>0.05</sub>	0.33	0.39	0.65	3.22
CV (%)	11.73	6.49	7.38	5.90
LS	*	*	*	*

In a column, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test.

Legend,

V<sub>1</sub>= BARI Soybean-5

V<sub>2</sub>= BARI Soybean-6

P<sub>1</sub>= Control (Without Priming)

P<sub>2</sub>= 3% *Moringa*

P<sub>3</sub>= 6% *Moringa*

P<sub>4</sub>= 2% *Aloe vera*

P<sub>5</sub>= 4% *Aloe vera*

NS= Non-significant

\*=Significant at 5% level of significance

\*\*=Significant at 1% level of significance

LS=Level of Significance

CV=Coefficient of variance

## CHAPTER V

### SUMMARY AND CONCLUSION

A pot experiment was conducted at agronomic research field-1, Hajee Mohammad Danesh Science and Technology university, Dinajpur, during December, 2023 to May, 2024 with a view to find out the effect of different organic priming solutions on the growth, yield and yield attributes of soybean cv., BARI Soybean 5 and BARI Soybean-6 under the Old Himalayan Piedmont Plain (AEZ-1). Two factor experiment included Factor A: Variety:  $V_1$ =BARI Soybean 5;  $V_2$ =BARI Soybean 6 and Factor B: control ( $P_1$ ), 3% *Moringa* ( $P_2$ ), 6% *Moringa* ( $P_3$ ), 2% *Aloe vera* ( $P_4$ ), 4% *Aloe vera* ( $P_5$ ) treatments was outlined in a Completely Randomized Design (CRD) with three replications. Total numbers of pot were 30. There were 10 treatment combinations. The data on crop growth characters like plant height, number of branches plant<sup>-1</sup>, Pod number plant<sup>-1</sup>. Yield and quality attributing parameters like, number of pods plant<sup>-1</sup>, length of the pod, number of unfilled pod plant<sup>-1</sup>, pod length, number of seeds pod<sup>-1</sup>, 100-seed weight, seed yield, stover yield, biological yield, harvest index. Data were analyzed using MSTAT-C computerized package program. The mean differences among the treatments were compared by Least Significance Difference (LSD) at 5% level of significance.

Results showed that different priming treatments of soybean had significant effect on the growth, yield of BARI soybean 5 and BARI Soybean 6.  $P_3$  Treatment performed best result in case of plant height at harvest, branch plant<sup>-1</sup> at 40, 60 and pod number, filled and unfilled pod, length of pod, seed pod<sup>-1</sup>, seed yield, stover yield, biological yield and harvest index. In case of plant height  $P_3$  (6% *Moringa*) best showed best performance at 20,40 60 DAS and at harvest showed best performance both in variety and priming effect and lowest plant height observed from  $P_1$  treatment(without priming). Maximum number of branch plant<sup>-1</sup> were recorded from 6% *Moringa* priming solution at 40 DAS, 60 DAS and at Harvest whereas minimum number was obtained from  $P_1$  (without priming). In case of the highest number of pod plant<sup>-1</sup>, pod length, seed pod<sup>-1</sup> and 100-seed weight that showed in the  $P_3$  treatments (6% *Moringa*). Seed yield, stover yield, biological yield and harvest index also influenced by different organic seed priming treatments of application and  $P_3$  (6% *Moringa*) gave maximum yield and lowest number of pod plant<sup>-1</sup>,

lowest seed yield, stover yield and harvest index was showed in P<sub>1</sub>(without priming) treatments.

Interaction effect of variety and different priming treatments also significantly affected growth, yield and quality of soybean. The tallest plant is at 20 DAS, 40 DAS from variety V<sub>2</sub> (BARI Soybean 6) with the treatments of (6% *Moringa*). Thereafter tallest plant height was observed from Harvesting stages (P<sub>3</sub>) with treatments of (6 % *Moringa*) time at 40 DAS at 60 DAS to at harvest. Number of branches plant<sup>-1</sup>, nodule number highest at combination of V<sub>2</sub>P<sub>3</sub> combination also showed better performance on yield attributing characters i.e. produced highest number of pod plant<sup>-1</sup>, pod length, seed pod<sup>-1</sup>, highest seed yield, stover yield and biological yield as compared with other treatment combination.

From the above summary, the following conclusion can be concluded that:

1. Among the different solution of organic priming increased the growth, yield and yield attributes of soybean.
2. Among the different variety (V<sub>2</sub>) and priming effects (P<sub>3</sub>) produced maximum yield and yield attributes of soybean
3. Among the treatment combinations, V<sub>2</sub>P<sub>3</sub> would be promising practice for soybean growth, yield and yield attributes

Hence, it can be advised to the farmers to application of organic priming for getting maximum yield of soybean.

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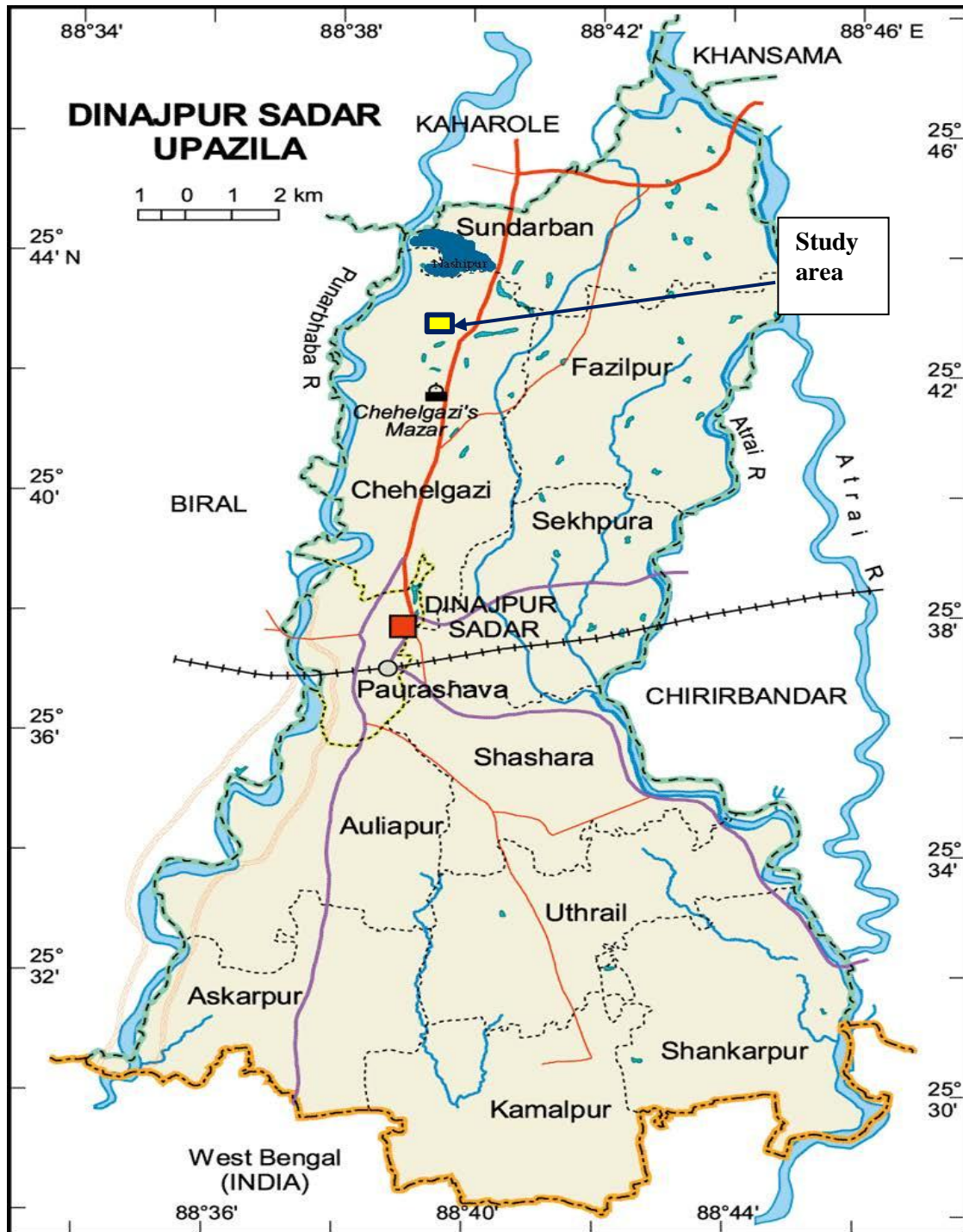
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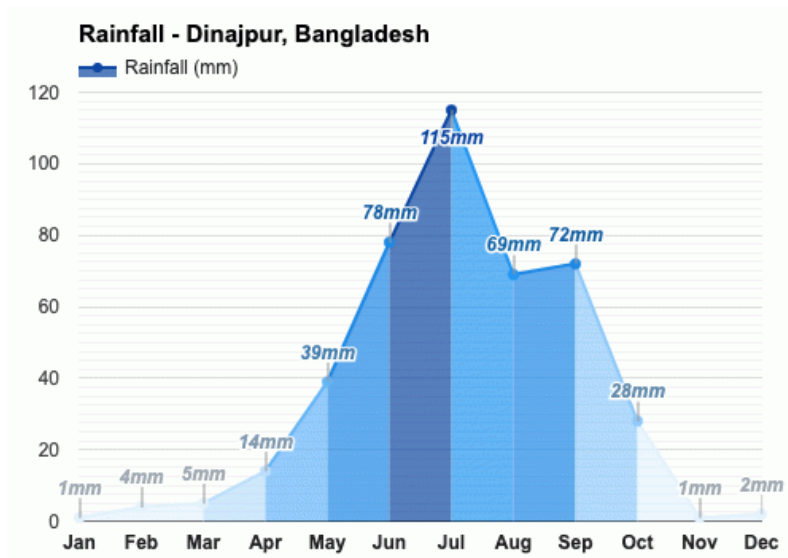
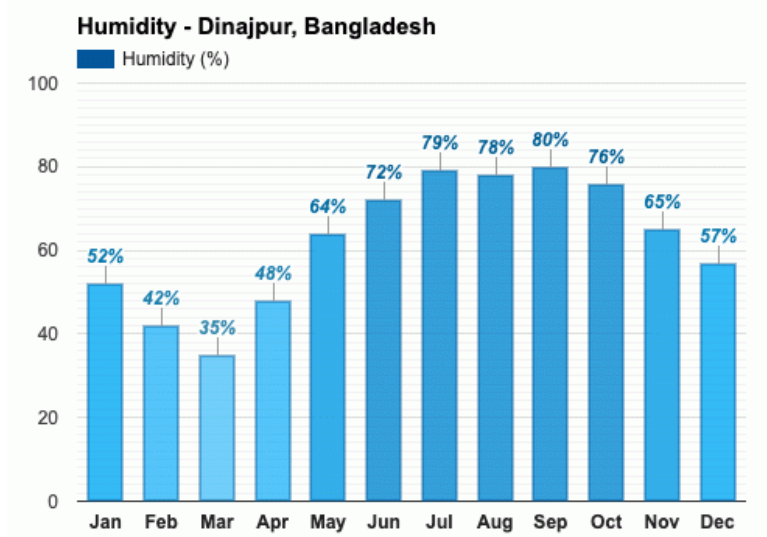
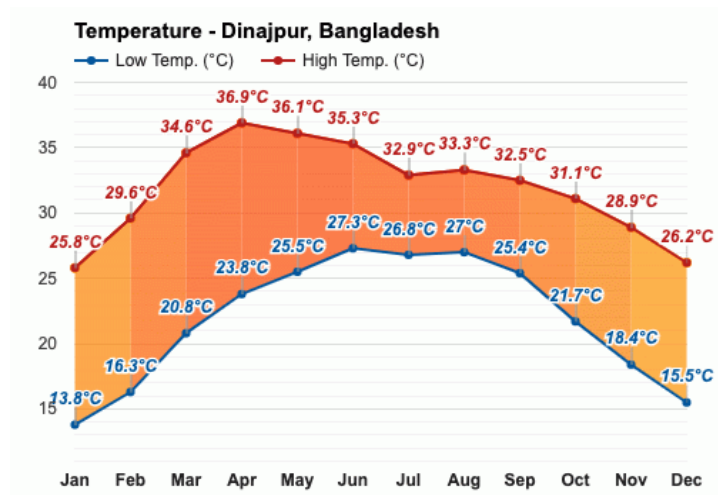
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# APPENDICES

Appendix I. Map showing the experimental site under study



## Appendix II. Weather data, Dinajpur, Bangladesh



**Appendix III: Morpho-physio-chemical properties of soil (collected before sowing of seeds) of the experimental field.**

**A. Morphological characteristics of the soil**

<b>Constituents</b>	<b>Characteristics</b>
Location	Agronomy shade house, Department of Agronomy ,Hajee Mohammad Danesh Science and Technology University, Dinajpur
Agro-ecological zone	Old Himalayan Piedmont Plain (AEZ-1)
Geographical position	25 <sup>0</sup> 38N latitude and 88 <sup>0</sup> 41E longitude
General Soil type	Non-calcareous dark grey floodplain
Parent materials	Old Brahmaputra River borne deposit
Land type	Medium high land
Elevation	37 meter above the mean sea level
Drainage	Well drained
Topography	Fairly level
Soil texture	Sandy loam
Soil Color	Dark grey
Flood level	Above flood level

**B. Physical properties of the initial soil (0-15 cm depth)**

<b>Constituents</b>	<b>Results</b>
Particle size analysis	
Sand (%) (0.2-0.002 mm)	58
Silt (%) (0.02-0.002 mm)	28
Clay (%) (<0.002 mm)	14
Soil textural class	Sandy loam

**Source: Results obtained from the mechanical analysis of the initial soil sample.**

### C. Chemical composition of the initial soil (0-15 cm depth)

Characteristics	Value (%)
pH (Soil: water = 1: 1.25)	5.41
Organic matter	1.48
Organic carbon	0.72
Total N	0.08
Available P (ppm)	11.20
Exchangeable P (meq)	0.10
Exchangeable Ca (meq)	2.48
Exchangeable Mg (meq)	2.29
Available S (ppm)	17.29
Available B (ppm)	0.13
Available Zn (ppm)	0.90
Available Fe (ppm)	51.90
Available Mn (ppm)	12.13

Source: Results obtained from the chemical analysis of the initial soil sample (SRDI, Dinajpur).

### Appendix IV. Mean square values for plant height at different days after sowing

Source of variation	df	PH (cm)			
		20 DAS	40 DAS	60 DAS	At harvest
Replication	2	25.634	118.641	94.419	21.207
Factor A	1	11.408*	6.627*	35.425*	57.547**
Factor B	4	39.791*	448.245**	378.651**	694.010**
Factor AB	4	3.823*	7.741*	71.385**	2.717NS
Error	18	53.986	89.319	140.915	116.458

Df= degrees of freedom, Factor A=Variety, Factor B= Seed Priming, Factor AB = Variety and Seed Priming

**Appendix V. Mean square values for number of branches plant<sup>-1</sup> at different days after sowing**

Source of variation	df	BN (number)		
		40 DAS	60 DAS	At harvest
Replication	2	0.78867	1.10067	1.7840
Factor A	1	0.17633NS	0.01633NS	0.0963NS
Factor B	4	2.52800*	5.85800**	9.0933**
Factor AB	4	0.07200*	0.06200*	0.4987*
Error	18	2.36467	2.29267	7.0627

Df= degrees of freedom, Factor A=Variety, Factor B= Seed Priming, Factor AB = Variety and Seed Priming

**Appendix VI. Mean square values for pod length, number of pod plant<sup>-1</sup>, grains pod<sup>-1</sup> and 100-seed weight**

Source of variation	df	Mean square values			
		PL	NPP	GPP	HGW
Replication	2	0.61629	29.24	0.71673	10.5727
Factor A	1	0.14700NS	61.63*	0.26320*	4.7203*
Factor B	4	4.41935**	759.18**	2.51669**	37.2113**
Factor AB	4	0.52887*	44.60*	0.06638*	5.3713*
Error	18	2.05105	407.40	0.97554	18.1940

Df= degrees of freedom, Factor A=Variety, Factor B= Seed Priming, Factor AB = Variety and Seed Priming

**Appendix VII. Mean square values for seed yield, stover yield, biological yield, harvest index of soybean**

Source of variation	df	Mean square values			
		GY	SY	BY	HI
Replication	2	0.05622	0.38041	0.2103	39.454
Factor A	1	0.52536**	0.29008*	1.5962**	41.452**
Factor B	4	2.03385**	1.41803**	6.5916**	176.145**
Factor AB	4	0.04565*	0.02757*	0.0302*	18.954*
Error	18	0.66578	0.90853	2.5507	63.532

Df= degrees of freedom, Factor A=Variety, Factor B= Seed Priming, Factor AB = Variety and Seed Priming

**Appendix VIII: Some photographs of my research works**

