Effect of seed priming with plant growth regulators on growth, biochemical changes and yield of Mung bean (Vigna radiata L.)

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Abstract

Seed priming is employed for better crop stand and higher yield in a range of crops. In order to evaluate the effect of seed treatments with growth regulators on the yield and yield components of mung bean (Vigna radiata L.) variety, a experiment was carried out under field condition at students instructional farm of Acharaya Narendra Deva University of Agriculture & Technology, Narendra Nagar, Ayodhya U.P. during kharif season 2019 based on a Randomized Blok Design with three replications variety of Narendra Mung-1 with seven treatments were taken. The maximum germination percentage (90.25%) was recorded with seed priming of GA3-100ppm over other treatments including control. Growth characters as plant height, total dry biomass, and chlorophyll content and nitrogen content in green leaves and protein content in mature seeds were found significantly superior with seed priming of GA3-100ppm followed by NAA-100ppm over control. Yield and yield contributing traits viz: number of pod clusters per plant (8.33), number of pods per plant (48.26), pod length (7.66cm), number of seeds per plant (416.66), number of seeds per pod (10.33), 100 seed weight (3.92g), seed yield per plant (14.36g), seed yield (11.66 q h-1) and harvest index (36.06%) were also found statistically superior with seed priming of GA3-100ppm followed by priming in NAA-100ppm over control. Generally, the use of growth regulators as a pre-treatment of seed increased the yield and yield components.

Keywords: Mung bean, GA3, biochemical, physiological, NAA, salicylic acid

Introduction

Mungbean is the third most important pulse crop of India after chickpea and pigeonpea (Singh and Singh, 2014) [22]. Mung bean (Vigna radiata (L.) Wilczek) is native to India and central Asia especially in tropical and subtropical Asia and belong to family Fabaceae and sub-family Papilionaceae (Singh and Singh, 2014) [22]. The nutritive value of mungbean is high and easily digestible protein with approximately 25-28%, oil 1.0-1.5%, fiber 3.5-4.5%, ash 4.5-5.5%, carbohydrate 62-65%, water 9.1%, and vitamins on dry weight basis (Singh et al., 2014) [22]. In India, pulses are grown over an area of 29.28 m ha with a production and productivity of about 22.40 m tonnes and 765 kg/ ha, respectively (Anonymous, 2017) [1]. This covers about 20% of total area and 8% of total grain production. These are the cheapest and best sources of vegetable proteins consisting of about 27 per cent of total dietary protein in our country and India has largest area and production of pulses in the world.

Plant growth regulators (PGRs) are known to influence plant growth and development at very low concentrations. They are non-toxic to plants over a wide range of concentration and effective in promoting the root system of a large number of plant species (Taiz and Zeiger 2006) [23]. Gibberellins (GAs) are the most important natural growth regulators and generally involved in the growth and development of different plant. They control seed germination, leaf expansion, stem elongation, and flowering (Magome et al., 2004 and Kumar et al., 2018) [15, 11]. Gibberellic acid (GA) is used to induce great changes in the growth characters, chemical composition, and yield criteria of the plant (Choudhury et al., 2013) [9]. Salicylic acid (SA) is a phytohormone of phenolic nature. It is ubiquitous in plants generating a considerable impact on plant growth, development, mineral uptake and transport, photosynthesis, and transpiration. Salicylic acid and other salicylates are known to affect
various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity (Arberg, 1981) [4].

Materials and Methods
The field experiments were carried out during kharif season of 2019 on students instructional farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar, (Kumarganj), Ayodhya. The seeds of mungbean (Narender mung-1) were soaked for 12 hr. with bio regulators gibberelllic acid (GA3), Salicylic acid and NAA with different concentrations as follows: control (unpriming), gibberellic acid (50 ppm), gibberellic acid (100 ppm), salicylic acid (50 ppm), salicylic acid (100 ppm), NAA (50 ppm), and NAA (100 ppm). The experiment was planed with complete randomized block design in three replications and morpho-physiological parameter were taken, Germination (%), dry weight per plant, Days to maturity, Chlorophyll and Nitrogen content (SPAD meter, Model:X55/M-PEA), Harvest Index (%) = [(Economic yield)/(Biological Yield)] x100.

Isolation of protein content in seeds: The soluble and insoluble protein content was estimated by using method of Lowery et al. 1951. The final colour is the result of biuret reaction of the protein with copper ion in alkaline medium and reaction of phosphomybdic turgustic reagent by the tyrosine and tryptophan present in the treated protein. Reagent: (A) 2% Na2CO3 in 0.1 N NaOH. (B) 0.5% CuSO4, 5H2O in 1% sodium potassium tartarte. (C) Alkaline copper solution mix 50 ml of reagent A with reagent B, (Discarded after day). (D) Carbonate copper solution, is the same as C expect for omissions of NaOH. (E) Diluted folin reagent. Extraction: First of all crushed the seed in powdery form and moist with 80% ethanol and centrifuged at 4000 rpm for 20 minutes. The residue left after 80% ethanol extraction was hydrolyzed in 5.0 ml of 0.3 NaOH for one hour and then centrifuged. Both the supernatants were pooled and the volume was made to 10 ml. Procedure: 0.5 ml aliquot was taken in test tube and mixed with 5 ml of reagent C allowed to stand for 10 minutes. Thereafter, 0.5 ml of reagent D was added with instant mixing after 30 minutes, OD was measured at 750 nm.

Statistical Analysis: Data recorded on various growth and yield attributes were subjected to statistical analysis by Fisher method of analysis of variance (Fisher and Yates 1949) [7].

Result and Discussion
Seed germination percentage: Seed priming enhanced germination percentage and maximum germination percentage was recorded GA3 acid and NAA with respect to control. Similar findings were also reported by Umair et al. (2010), Kundu, et al. (2017) [13] Kumar et al. (2017) the effect of different concentrations of GA3 is the best germination rate of 92% was achieved in (GA3-100ppm) followed by 80% in (NAA-100ppm) and 70% in (salicylic acid-100ppm).

Plant height (cm): The maximum plant height (14.15, 39.07, 52.33, 59.33 at harvest respectively) was recorded with seed priming of GA3 (100ppm) as compared to control at all the stages of crop growth (20, 40, 60 DAS and at harvest stages). The higher plant height was achieved with application of GA3 and NAA was found more pronounced and both treatments registered significant increase in plant height as compared to unprimed control at all the stages of observation., which might be due to enhanced stem elongation because of application of plant growth regulators particularly GA3, contributed a lot in affecting plant height of mungbean. These results are agreement with these results is in accordance to Hoque et al. (2002) [8] and Kumar et al. (2017).

Table 1: Effect of seed priming with plant growth regulators on germination percentage and plant height of mung bean during kharif season

| Treatments          | Germination (%) | 20 DAS | 40 DAS | 60 DAS | At harvest |
|---------------------|-----------------|--------|--------|--------|------------|
| Control             | 79.66           | 9.04   | 28.29  | 43.75  | 47.00      |
| GA3 (50ppm)         | 83.26           | 11.03  | 33.33  | 47.33  | 54.66      |
| GA3 (100ppm)        | 90.25           | 14.15  | 39.07  | 52.33  | 59.33      |
| Salicylic acid (50ppm) | 83.87         | 10.49  | 33.00  | 46.33  | 54.29      |
| Salicylic acid (100ppm) | 85.45       | 12.66  | 35.33  | 47.00  | 56.33      |
| NAA (50ppm)         | 83.72           | 10.75  | 33.33  | 43.66  | 54.41      |
| NAA (100ppm)        | 86.56           | 13.48  | 36.66  | 48.00  | 57.08      |
| SEm±                | 1.14            | 0.39   | 0.64   | 0.58   | 0.62       |
| CD at 5%            | 3.52            | 1.20   | 1.98   | 1.78   | 1.90       |

Fig 1: Effect of seed priming with plant growth regulators on germination percentage and plant height of mung bean during kharif season
**Number of branches per plant:** All the treatments showed significant difference on number of branches at all the growth stages of observations with respect to control at 40 and 60 DAS and at harvest stages. Statistically significant more number of branches has observed with seed priming of GA\textsubscript{3} 100 ppm (6.66, 8.66 and 8.99 branches per plant) at 40 and 60 DAS, at harvest respectively, followed by seed priming with NAA 100 ppm over rest of the treatments. Where as, minimum number of branches was recorded with seed priming of NAA 50 ppm (5.05, 6.26, & 6.33 plant\textsuperscript{-1}) at 40, 60 DAS and at harvest stage over control.

**Total dry biomass (g):** The maximum increase in total dry biomass (2.66, 9.95, 19.08 and 29.88g) was observed with seed priming of GA\textsubscript{3}-100ppm at 20, 40, 60 DAS and at harvest stages. The higher total dry biomass achieved with seed priming of GA\textsubscript{3}-100ppm registered significant increase in the dry biomass per plant as compared to unprimed control at 20, 40, 60 DAS and at harvest stages of crop which might be due to stem elongation, increase in cell size of leaves and another possible growth factors as influenced by GA\textsubscript{3} application. The increase in plant dry biomass due to seed priming treatments indicated that the photosynthetic activity and efficiency of the leaves have been increased which contributed to dry biomass production. This is further supported by similar finding have been reported by Ibrahim \textit{et al.} (2009)\textsuperscript{[9]} revealed that GA\textsubscript{3} (100ppm) application led to increase in plant height, average number of leaves, leaf area per plant and dry weight of shoot in \textit{vicia faba}. These findings was accordance with Fatma \textit{et al.} (2012)\textsuperscript{[6]}.

**Table 2:** Effect of seed priming on number of branches per plant and total dry biomass per plant (g) of mung bean during \textit{kharif} season

| Treatments               | 40 DAS | 60 DAS | At harvest | Total dry biomass (g) per plant |
|--------------------------|--------|--------|------------|--------------------------------|
| Control                  | 3.93   | 5.00   | 6.00       | 1.96 6.01 15.00 25.56          |
| GA\textsubscript{3} (50ppm) | 5.33   | 6.66   | 6.85       | 2.06 7.63 16.53 27.33          |
| GA\textsubscript{3} (100ppm) | 6.66   | 8.66   | 8.99       | 2.66 9.95 19.08 29.88          |
| Salicylic acid (50ppm)   | 5.75   | 6.26   | 6.98       | 2.00 7.62 16.44 26.15          |
| Salicylic acid (100ppm)  | 5.84   | 6.73   | 8.26       | 2.38 8.5 16.83 27.65           |
| NAA (50ppm)              | 5.05   | 6.26   | 6.98       | 2.07 7.9 16.44 26.87           |
| NAA (100ppm)             | 5.95   | 7.33   | 8.41       | 2.43 8.13 17.00 28.00          |
| SE\textsuperscript{±}     | 0.28   | 0.32   | 0.26       | 0.15 0.39 0.45 0.53            |
| CD at 5\%                | 0.87   | 0.98   | 0.80       | 0.40 1.20 1.30 1.55            |

**Fig 2:** Effect of seed priming on number of branches per plant and total dry biomass per plant (g) of mung bean during \textit{kharif} season

**Chlorophyll content:** Chlorophyll content in green leaves have been significantly affected by seed priming of plant growth regulators at various stages of the crop. The maximum chlorophyll content in leaves (9.96, 10.66, and 10.33 SPAD Value) was analyzed with seed priming of GA\textsubscript{3}-100ppm at 20, 40 and 60 DAS of the crop. The higher chlorophyll content analyzed due GA\textsubscript{3}-100ppm which might be due to enhanced cell division and increased chloroplast development in the plant that may contribute in improving chlorophyll content in leaves. These results are supported by Shairy and Hegazi (2009)\textsuperscript{[9]} the effect of GA\textsubscript{3}-100ppm, NAA-100ppm and salicylic acid-100ppm applied as foliar spray at different growth stages on chlorophyll content in pea. They reported significantly Increase in total chlorophyll content in leaves. Preeti \textit{et al.} (2018) seeds were primed with salicylic acid (SA) @ 20 µg mL\textsuperscript{-1} and 40 µg mL\textsuperscript{-1} along with hydro priming for harvest stages. The higher total dry biomass achieved with seed priming of GA\textsubscript{3}-100ppm registered significant increase in the dry biomass per plant as compared to unprimed control at 20, 40, 60 DAS and at harvest stages of crop which might be due to stem elongation, increase in cell size of leaves and another possible growth factors as influenced by GA\textsubscript{3} application. The increase in plant dry biomass due to seed priming treatments indicated that the photosynthetic activity and efficiency of the leaves have been increased which contributed to dry biomass production. This is further supported by similar finding have been reported by Ibrahim \textit{et al.} (2009)\textsuperscript{[9]} revealed that GA\textsubscript{3} (100ppm) application led to increase in plant height, average number of leaves, leaf area per plant and dry weight of shoot in \textit{vicia faba}. These findings was accordance with Fatma \textit{et al.} (2012)\textsuperscript{[6]}.

**Protein content:** The higher protein content in seeds was also obtained with application of GA\textsubscript{3}-100ppm. The higher protein content in seeds analyzed with GA\textsubscript{3}-100ppm which attributed with increased in structural component of RNA molecules of amino acids and also GA\textsubscript{3} cause marked increased DNA, RNA and protein synthesis in ribosome which is known as site of protein synthesis in plants. The increase in protein content was also supported by Shairy \textit{et al.} (2009)\textsuperscript{[9]} conducted pot experiment to investigate the effect of acetylsalicylic acid (10 and 20 ppm), IBA (50 and 100 ppm) and GA\textsubscript{3} (50 and 100 ppm) on protein at different growth stages. They reported significantly increase in total soluble protein in pea and Jain \textit{et al.} (2008)\textsuperscript{[6]}.
Table 3: Effect of plant growth regulators on chlorophyll content, nitrogen content (SPAD value) and protein content in mung bean during kharif season

| Treatments          | Chlorophyll content | Nitrogen content | Protein content (%) |
|---------------------|---------------------|------------------|---------------------|
|                     | 20 DAS   | 40 DAS   | 60 DAS   | 20 DAS   | 40 DAS   | 60 DAS   |
| Control             | 7.04     | 7.59     | 7.71     | 0.42     | 0.45     | 0.41     | 23.01    |
| GA3 (50ppm)         | 8.44     | 8.73     | 8.92     | 0.44     | 0.50     | 0.42     | 23.15    |
| GA3 (100ppm)        | 9.96     | 10.66    | 10.33    | 0.57     | 0.58     | 0.46     | 24.26    |
| Salicylic acid (50ppm) | 8.48     | 8.91     | 8.68     | 0.49     | 0.53     | 0.42     | 23.03    |
| Salicylic acid (100ppm) | 8.64     | 9.31     | 9.03     | 0.55     | 0.55     | 0.44     | 23.90    |
| NAA (50ppm)         | 8.09     | 8.44     | 8.25     | 0.52     | 0.54     | 0.42     | 23.03    |
| NAA (100ppm)        | 9.00     | 9.57     | 9.41     | 0.56     | 0.57     | 0.45     | 24.03    |
| SEm ±               | 0.43     | 0.27     | 0.23     | 0.02     | 0.02     | 0.02     | 0.31     |
| CD at 5%            | 1.25     | 0.84     | 0.71     | 0.08     | 0.06     | 0.05     | 0.94     |

Yield and yield contributing parameters: The maximum number of pod clusters per plant and number of pods per plant, pod length were recorded with seed priming of GA3-100ppm. The above higher yield contributing parameters obtained with seed priming GA3-100ppm which might be due to maximum net photosynthetic rate in leaves and better translocation of photosynthates and metabolites. Though, the way of various physiological mechanisms involves in the plant with seed priming of NAA-100ppm also played a significant role in enhancing above yield attributes up to some extent. The present finding is in accordance with Salman et al. (2015) reported that the response of seed priming and foliar application of plant growth regulators (GA3), NAA and osmotic salicylic acid increase number of pod cluster per plant, 100 seed weight and seed yield per plants of the mung bean.

The higher number of seeds per plant obtained with seed priming of GA3-100 ppm. May be because of increased cell division, promotion of orderly development of embryos of seeds and higher level of photosynthates that led to increase in number of seeds per plant. The Similar findings also reported by Ali and Muhsen (2014) [2]. The seed yield (q ha⁻¹) was significantly affected with seed priming of various primers. Similar result was found by Ali and Mahmood (2013) [1]. The maximum seed yield (11.66 q ha⁻¹) was found with seed priming of GA3-100 ppm closely followed by seed priming with NAA-100 ppm (10.66 q ha⁻¹) and seed priming with salicylic acid-50 ppm (9.66 q ha⁻¹). The higher seed yield...
obtained with seed priming with GA₃-100 ppm which might be due to increased yield contributing parameters viz., number of pods clusters and pods per plant, pod length, number of seeds per pod, number of seeds per plant, 100 seed weight and seed yield per plant which in combination contributed a lot in improving seed yield (q ha⁻¹) of mungbean during present investigation. The higher harvest index (36.06%) was calculated with seed priming of GA₃-100 ppm followed by seed priming with NAA-100 ppm (35.55%). The present finding is closed conformity with Umair et al. (2011). These findings was accordance with Naqvi and Nooris (2014) an experiment was conducted to determine the most effective PGRs for the optimum performance of chickpea cultivars and to select the most promising cultivar. The PGRs GA₃ (100ppm) and followed by NAA (100ppm). Were found in increasing of harvest index.

### Table 4: Effect of seed priming on yield attributes of mungbean during kharif season

| Treatments         | Number of Pod Clusters per Plant | Number of Pods per Plant | Pod Length (Cm) | Number of Seed per Plant | Number of Seeds per pod | 100 Seed Weight (g) | Seed yield (g) per plant | Seed yield (g) per (q ha) | Harvest index (%) |
|--------------------|----------------------------------|--------------------------|-----------------|--------------------------|-------------------------|---------------------|------------------------|--------------------------|------------------|
| Control            | 5.66                             | 36.14                    | 4.74            | 307.66                   | 6.45                    | 2.93                | 10.73                  | 9.00                     | 31.12            |
| GA₃ (50ppm)        | 6.66                             | 40.44                    | 6.00            | 378.00                   | 8.07                    | 3.29                | 12.35                  | 10.32                    | 33.36            |
| GA₃ (100ppm)       | 8.33                             | 48.26                    | 7.66            | 416.66                   | 10.33                   | 3.92                | 14.36                  | 11.66                    | 36.06            |
| Salicylic acid (50ppm) | 6.33                         | 40.81                    | 6.07            | 345.33                   | 8.33                    | 3.32                | 12.07                  | 9.66                     | 32.63            |
| Salicylic acid (100ppm) | 7.00                       | 43.66                    | 6.94            | 395.00                   | 8.82                    | 3.50                | 12.75                  | 10.18                    | 34.96            |
| NAA (50ppm)        | 6.33                             | 41.07                    | 6.37            | 355.07                   | 8.33                    | 3.30                | 12.56                  | 9.66                     | 33.96            |
| NAA (100ppm)       | 7.33                             | 45.00                    | 7.07            | 401.22                   | 9.00                    | 3.62                | 13.33                  | 10.08                    | 35.55            |
| SEm±               | 0.32                             | 1.29                     | 0.40            | 16.54                    | 0.35                    | 0.15                | 0.41                   | 0.24                     | 0.50             |
| CD at 5%           | 0.98                             | 3.21                     | 1.23            | 48.26                    | 1.06                    | 0.46                | 1.26                   | 0.73                     | 1.47             |

![Fig 4: Effect of seed priming on yield attributes of mungbean during kharif season](image)

### Conclusion

It can be concluded that seed priming of GA₃ at 100ppm and NAA at 100ppm was an effective treatment to increase mungbean growth, photosynthetic pigments, metabolic activities, yield, yield components, and chemical composition of the yielded seeds as low input technology for improving the yield of mungbean. It was a needed complementary research on mungbean as double purpose crop (forage and seed).

### Reference

1. Ali EA, Mahmoud AM. Effect of foliar spray by different salicylic acid and zinc concentrations on seed yield and yield components of mung bean in sandy, Soil Asian Journal of Crop Sci 2013;10(33):40.
2. Ali HI, Muhsen NA. Effect of seeding times, foliar treatments (with salicylic acid, humic acid and high phosphorus fertilizer) and their interaction on mung bean (Vigna radiata L. Wilczek) yield. Journal of Agriculture and Veterinary Science 2014, ISSN: 2319-2380.
3. Anonymous. Agronomy project coordinators report mungbean and urd bean (2016-17). All India coordinated research project on Mullarp ICAR-Indian Institute of pulse research Kanpur 2016-17, 208024.
4. Arberg B. Plant Growth Regulators XLI. Mono Substituted Benzoic Acid. Swedish Journal of Agricultural Research 1981;11:93-105.
5. Choudhury S, Islam N, Sarkar MD, Ali MA. Growth and yield of summer tomato as influenced by plant growth regulators. Int J Sustain Agric 2013;5(1):25-28.
6. Fatma T, Jean-Jacques D, Mustapha T. Flamingo is a new common bean (Phaseolus vulgaris L.) genotype with tolerance of symbiotic nitrogen fixation to moderate salinity African J Agric. Res 2012;7:2016-2024.
7. Fisher RA, Yates F. Statistical tables for biological, agricultural and medical research. No. Ed. 3. pp. viii+112, 1949.
8. Haque, Rahman MS. Bangladesh. View Article. Scale/Scope: 3 counseling centers. Evaluation Design: Longitudinal - 114 mother-child pairs completed one-year 2002:186(4):547-52. doi: 10.1086/341566. Epub
9. Ibrahim ME, Bekheta MAA, El-Moursi, Gaafar NA. Improvement of growth and seed yield quality of Vicia faba L. plants as affected by application of some bioregulators Australian Journal of Basic and Applied Sciences 2007;1(4):657-666, 2007 ISSN 1991-8178 ©, INSNet Publication.
10. Jain RK, Jain AK, Gera VK. Effect of growth regulators on leg haemoglobin biosynthesis in chickpea nodules. Banaras Hindu University CAB Legume Research 2008;31(4):303305.8.

11. Kumar AS, Sakthivel N, Subramanian E, Kalpana R, Janaki P, Rajesh P. Influence of foliar spray of nutrients and plant growth regulators on physiological attributes and yield of finger millet (Eleusine coracana (L.) Gaertn.). Inter J of Chem Studies 2018;6(3):2876-3879.

12. Kumar R, Yadav RK, Sharma N, Yadav A, Nehal N. Influence of plant growth regulators on biochemical changes of mungbean (Vigna radiata L. Wilczek). Journal of Pharmacognosy and Phytochemistry 2018, SP1: 386-389.

13. Kundu S, Das B, Yonzone R. Effect of different hydro and osmopriming materials on germination and seedling growth of mungbean. International Journal of Chemical Studies 2017;5(5):99-103.

14. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the folin phenol reagent. J Biol. Chem 1951;193:265.

15. Magome H, Yamaguchi S, Hanada A, Kamiya Y, Odadoi K. Dwarf and delayed-flowering 1, a novel Arabidopsis mutant deficient in gibberellins biosynthesis because of over expression of a putative AP2 transcription factor. Plant J 2004;37:720-729.

16. Naqvi AZ, Noori S. Effect of surfactant structure on the mixed micelle formation of cationic gemini–zwitterionic phospholipid systems. Journal of Surfactants and Detergents 2014;17(3):409-417.

17. Painkra P, Shrivatava R, Nag SK, Kute I. Correlation analysis for seed yield and its attributing traits in soybean (Glycine max L. Merrill). Int. J Curr. Microbiol. App. Sci 2018;7(04):2034-2040. doi: https://doi.org/10.20546/ijcmas.2018.704.234

18. Shalama SS, Trivedi M, Busheva AA, Araf G, Garal L, Eradei. Effect of NaCl salinity on growth, cation accumulation chloroplast structure and function in wheat cultivars differing in salt tolerance. Plant Physiology 1994;144:241-247.

19. Shariy EAM, Hegazi AM. Effect of acetylsalicylic acid, indole-3-butyric acid and gibberellic acid on plant growth and yield of pea (Pisum sativum L.) Aust. J Bas. Appl. Sci 2009;3(4):3514-3523.

20. Shraiy MAE, Amira MH. Effect of Acetylsocyclic acid, Indol-3-Bytric Acid and Gibberellic Acid on Plant Growth and Yield of Pea. Australian J of Basic and Applied Science 2009;3(4):3514-3523.

21. Singh P, Singh V, Singh N, Pandurangam V, Shahi JP. Ameliorating effect of seed priming by salicylic acid on biochemical traits in Rabi maize (Zea Mays L.) genotypes under normal and delayed sowing. Journal of Pharmacognosy and Phytochemistry 2018;7(2):2923-2927.

22. Singh SK, Singh PS. Screening of mungbean (Vigna radiata L) against major insects-pests Current advance in agri. Sci 2014;6(1):85-87.

23. Taiz L, Zeiger E. Plant physiology. 4th Ed. Sinauer Associates, Inc., Publishers, USA 2006.

24. Umair A, Ali S, Sarwar M, Bashir K, Taree MJ, Malik MA. Assessment of Some Priming Techniques in Mungbean (Vigna radiata). Pakistan J Agric. Res 2013;26(4):2013.