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Performance of black gram (*Vigna mungo* L. Hepper) with organic amendments

Dhivya R.S. . Lala I.P. Ray

School of Natural Resource Management, College of Postgraduate Studies in Agricultural Sciences (CAU- Imphal), Barapani, Meghalaya

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ABSTRACT

A field experiment was conducted to study the performance of black gram (*Vigna mungo* L. Hepper) with organic amendments under mid hills of Meghalaya during 2018-19 in the experimental farm of College of Agriculture, Kyrdemkulai with various organic inputs. There are 12 treatments comprising of priming, mulching and manuring. FYM (Farmyard manure), pig manure, poultry manure and maize stover mulch were used as organic inputs. Seed priming was done with liquid wash of manures and also with water as control. Based on the field experiments, treatments under combination of all the organic amendments recorded the higher crop growth parameters. The results of the study indicated that higher yield (1,045.13 kg ha^{-1}) was registered under T9 followed by T8 (961.79 kg ha^{-1}) with the harvest index of 30.25 and 28.88 respectively. Thus, the organic amendments (seed priming, mulching and manuring) had significantly influenced the growth and yield of black gram and also the economics. Therefore, poultry manure at the rate of 8 t ha^{-1}, maize stover mulch at the rate of 5 t ha^{-1} and seeds primed with poultry manure liquid wash can be recommended for higher yield of black gram.

1. Introduction

Pulses are one of the important food crops contributing towards the future global nutritional security, besides addressing food security and contributing to healthy diets. Knowing the importance of pulses, the United Nations General Assembly in the 68th session of United Nations declared 2016 as the "International Year of Pulses". In Meghalaya, area under total pulses is 5,901 ha with the production 7970 tonnes (Anonymous-I, 2017b). The average production of pulses in Meghalaya is 1,474 kg ha^{-1} (Anonymous-I, 2017a). Even though, the average productivity of pulses in North East Hill (NEH) Region(848 kg ha^{-1}) is higher than the national average, which is 764 kg ha^{-1} but the rate of pulse production is increased at much slower pace and the growth rate was less than the population growth. This low production may be due to several abiotic and biotic factors (Gupta *et al.,* 1998). Abiotic and biotic factors can be overcome by application of mulches and organic manures. Mulches were effective in controlling weeds and also conserving in-situ moisture (Uwah and Iwo, 2011). Soil organic matter and moisture was found to improve under mulching. Thus, mulching serves as one of the best alternatives to manage both the abiotic and biotic factors like rainfall, soil temperature, weeds, *etc.* which results in good crop establishment and increase the water use efficiency (Khurshid *et al.,* 2006). For better crop emergence, seed priming is one of the low-

*Corresponding author: lalaipray@rediffmail.com

cost practices to improve the seed performance by rapid and synchronized germination. Soil fertility is one of the determining factors for crop production as it affects the nutrient availability in soil and nutrient uptake by the crops. Similarly, manures input also improve the crop growth and yield by enhancing the uptake of nutrients by the plants from soil and improve the soil fertility by increasing the available nutrients. Some of the studies have reported that addition of organic manure improves the nitrogen fixation of black gram by releasing some phyto-chemicals, which maintains the symbiotic relationship and beneficial for root nodulation (Anbuselvi and Rebecca, 2013; Gerald, 2004). Therefore, this study has been conducted with the hypothesis of yield of black gram may be improved by different sources of organic manuring and mulching and with the objective to evaluate the influence of different types of organic sources on growth and yield of black gram.

2. Materials and Methods

A field experiment was conducted during April-July, 2018 at the College of Agriculture, Kyrdemkulai, Ri-bhoi district, Meghalaya with "Uttara" black gram variety. The experimental site is situated at 91^o 18' to 92^o 18' East longitude and 25^o 40' to 26^o 20' North latitude and at an altitude of 950 m above the mean sea level (MSL). The climate of Ri-bhoi is classified as subtropical humid type with high rainfall and cold winters During the experimentation period, maximum weekly rainfall of 24.9 mm was received during 27th standard week (June), the total amount of 163.6 mm was received during the crop-growing season. Mean weekly maximum temperature was highest during 23rd standard week (29.15°C) and lowest in 51st standard week (19.87°C). Mean weekly minimum temperature was highest during 38th standard week (18.80°C) and lowest in 51st standard week (3.23°C). The average recorded weekly relative humidity ranged from 81.3 to 92.4% during the morning hour and 43.6 to 78.8% during the evening hour. The red clay loam soil has initial organic carbon and pH of 1.8%, 5.1 respectively. The available nitrogen (N), phosphorus (P) and potassium (K) at 0-15 cm were 227.81 kg ha^{-1}, 16.25 kg ha^{-1} and 350 kg ha^{-1} respectively. Manures were incorporated before sowing. The total N, P and K content of FYM (Farmyard manure), pig manure, poultry manure and maize stover mulch were 0.21, 0.35 and 0.25%, 0.8, 0.57 and 1.3 %, 1.8, 0.5 and 0.8% and 0.5, 0.16 and 1.26% respectively.

FYM, pig manure, poultry manure and maize stover mulch were applied at the rate of 10 t ha^{-1}, 8 t ha^{-1}, 1.5 t ha $^{-1}$ and 5 t ha^{-1} respectively (Das *et al.*, 2016). Seed priming was done with the three organic manure liquid wash and water. Liquid wash were obtained by soaking the manures in water in the ratio of 1: 10 for 24 hours with intermittent soaking. Later the slurries were filtered and seeds were soaked overnight in the respective manure liquid wash (Kanto *et al.,* 2014). Before sowing the seeds were shade dried. Seed rate and spacing adopted was 25 kg ha^{-1} and 30×10 cm respectively. First irrigation was given after sowing and later at flowering and pod filling stages when required. Total of 12 treatments consisted of seed priming (SP), three organic manures and maize stover application along with control was replicated thrice adopting Randomized Block Design (RBD).

The treatments were

T_1 – FYM	FYM L – FYM liquid wash
T_2 - FYM+ Mulch	PM L – Pig manure liquid wash
T_3 - FYM+ SP (FYM L) + Mulch	PoM L – Poultry manure liquid wash
T_4 - Pig manure	
T_5 - Pig manure + Mulch	
T_6 - Pig manure + SP (PM L) + Mulch	
T_7 - Poultry Manure	
T_8 - Poultry Manure + Mulch	
T_9 - Poultry Manure + SP (PoM L) + Mulch	
T_{10} – Control	
T_{11} - Control + Mulch	
T_{12} - Control + SP (Water) + Mulch	

For biometric observations, five plants were randomly selected from each plot and were tagged excluding the plant situated in the border rows. All the observations were recorded from these tagged plants (sample plants) at 15 days interval *i.e.* on 15, 30, 45, 60, 75 and 90 days after sowing (DAS) while yield attribute were taken at the time of harvesting. For recording the leaf area and biomass, destructive sampling procedure was adopted and the samples were collected from the border plants of the experimental field. The data obtained from various studies during investigation were statistically analyzed by using the technique of analysis of variance for randomized block design over the computer. The difference between the treatment means was tested as for their statistical significance with appropriate critical difference (C.D) value at 5% level of significance as explained by Gomez and Gomez (1984).

Plant height (cm):
The height of the plant in cm was determined from the sample tagged plants by measuring the height from the base to tip of the plant at 15 days interval and their mean was computed and expressed in cm.

Dry matter accumulation per plant (g):
Five plants from each plot (not the tagged one) were selected and picked randomly at 15 days interval. After washing properly, *i.e.* after removal of foreign particles, excess moisture was removed with the help of blotting paper. After that, it was kept in the oven for about 48 hr at 60 ^{0}C till a constant weight was obtained. The dried weight of destructive samples were recorded and dry matter accumulation was calculated accordingly.

Table 1. Crop calendar

Sl. No.	Cultural Operation	Date of Operation
1.	Field preparation	5th April 2018
2.	Application of manures	7th April 2018
3.	Field layout and Seed priming	9th April 2018
4.	Sowing	10th April.2018
5.	Application of maize stover mulch	16th April 2018
6.	Gap filling	22nd April 2018
7.	Weeding	5th May 2018 (as and when required)
8.	Harvesting	11th July 2018

Number of pods per plant:
Numbers of pods per plant were recorded from five randomly selected tagged plants were counted and summed up and the average value was calculated. Their mean was expressed as numbers of pods per plant.

Number of grains per pod:
The grains collected from the pods of five tagged plants were counted separately and the mean value was expressed as the numbers of grain per pod.

Grain weight (g per plant):
Seed yield per plant was determined from tagged plant and expressed in g per plant.

Test weight (g)
After threshing and cleaning, thousand seeds are randomly counted, and weighed for each treatment.

Economic yield (kg ha^{-1})
Total grain yield per plot was calculated after threshing and drying of pods. The yield was converted into kilograms per hectare using suitable conversion factor.

Biological yield (kg ha^{-1})
Biological yield was obtained by summing the pod yield with stover yield per square meter, and later it was converted to kg per ha.

Harvest Index (%)
The harvest index was calculated by dividing the economic yield with the biological yield and is expressed in percentage by using the equation (2).

Harvest Index (%) ….=.. (2) ......(2)

Benefit cost ratio(BCR):
Utility of adopting different practices was compared by using the following economic parameters:
Gross return = (Grain yield* Minimum support price of black gram per kg) + (Stover yield*local price of stover per kg)
Minimum support price of black gram was Rs. 56 kg^{-1}
Net return= Gross return – Cost of cultivation

$$\textbf{Benefit cost ratio} = \frac{\text{Gross returns } (Rs.ha^{-1})}{\text{Cost of cultivation } (\text{Rs.}ha^{-1})}$$

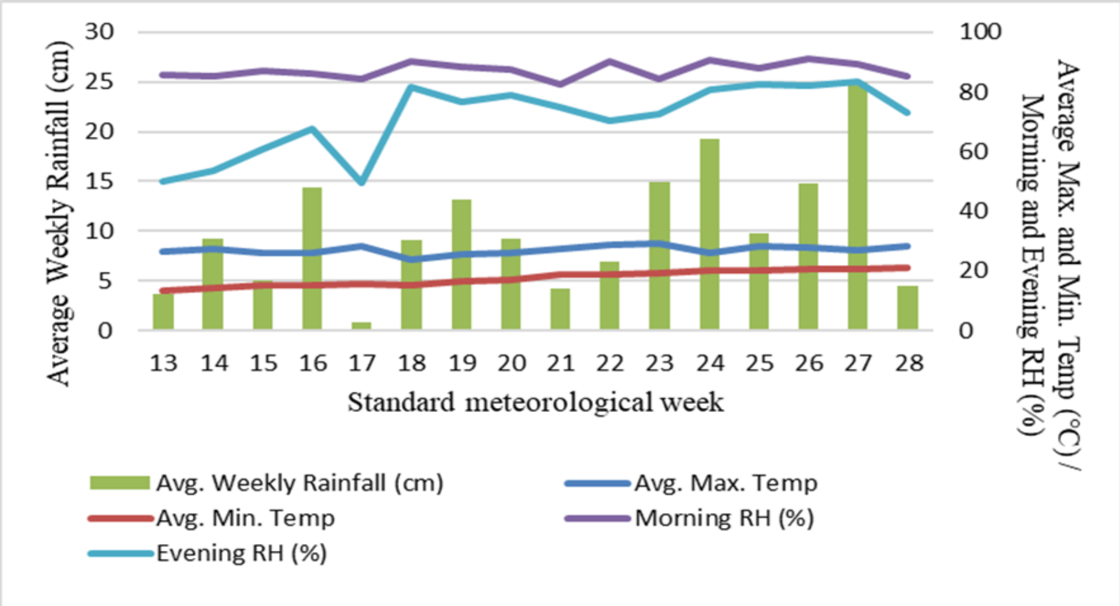

Figure 1. Weekly weather data prevailed during crop season

3. Results and Discussion

The plant height (cm), number of pods per plant, number of seeds per pod, seed weight per plant (g), grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) and HI (%) is presented in Table 2. The BCR is represented in Table 3.

Plant height

The plant height was the result of increased source production and was found significant throughout the crop growth period. At harvest, the plant height of primed seeds with poultry manure liquid wash along with poultry manure incorporation and application of mulch recorded the highest plant height of 52.94 cm. The treatments under the combination of priming and mulching in the respective manure treatments as shown in the Table 2 were observed to be significantly different from the treatments involving mulching and manuring or manure incorporation alone. The findings were supported by Bandyopadhyay, 2016 and Gunasekar *et al*., 2017 and they revealed that priming of seeds promoted height of the plant and this increase in plant height is might be due to the availability of high energy compounds at seedling stage. They also stated that plant height was positively influenced by priming as it results in better translocation of growth hormones which increases the hypocotyl size and promotes the nodal height of the plants. The results are also similar with the findings of Bhanudas, 2010 and Kumar, 2006 stated that plant height was maximum under mulching.

Yield attributes

Organic amendments had not significantly influenced the number of pods per plant and was found maximum (20.78) in the poultry manure incorporated treatments. But significant results were obtained in number of seeds per pod among all the treatment combinations. Maximum (5.80) number of seeds per pod was found in seeds treated with poultry manure liquid wash, poultry manure incorporated along with maize Stover mulch applied treatment. This maximum number of seeds per pod might be due to the greater production of assimilates, interaction effect of organic amendments resulted in greater uptake of nutrients and increased translocation of photosynthates, which holds better source-sink relationship. This finding was closely resembled to Gohain *et al.,* 2017 and Karmore, 2016. The findings of Gunasekar *et al.,* 2017 reported that higher number of seeds under primed treatment was might be due to the increased mobilization of nutrients results in increased number of filled seeds. They also stated that it enhances the pollen fertilization and pollen abortion was less by induced calcium metabolism.

Seed weight per plant also follows the same trend that the treatment involved all three organic amendments recorded the maximum seed weight. The Table 2 showed that seeds treated poultry manure liquid wash, poultry manure incorporated along with maize stover mulch applied treatment obtained the greater seed weight of 4.94 g per plant. This varies with test weight, number of seeds per pod and number of pods per plant. This maximum seed

Table 2. Effect of organic amendments on performance of black gram

Treatments	Plant height (cm)	Nos. of seeds per pod	Nos. of pods per plant	Seed weight per plant (g)	Test weight (g)	Economic yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
T_1	47.88	4.77	19.30	3.81	41.34	808.25	2169.31	27.13
T_2	48.79	4.80	19.33	3.86	42.52	829.12	2257.88	26.94
T_3	50.50	5.17	19.90	4.43	42.97	945.57	2358.12	28.58
T_4	48.17	4.78	19.17	3.83	41.79	809.89	2236.07	26.81
T_5	50.97	4.90	19.45	3.96	41.80	855.19	2370.84	26.48
T_6	51.65	5.30	20.00	4.39	41.43	947.68	2437.77	28.02
T_7	47.78	5.22	20.27	4.36	41.17	927.71	2292.80	28.98
T_8	49.18	5.28	20.73	4.50	40.87	961.79	2382.72	28.88
T_9	52.94	5.80	20.80	4.94	40.88	1045.13	2430.48	30.25
T_{10}	35.52	4.63	17.23	3.20	39.64	619.63	1691.58	26.41
T_{11}	37.94	4.70	17.33	3.22	39.69	630.90	1730.42	26.57
T_{12}	41.11	4.73	18.13	3.42	39.95	702.29	1955.66	26.58
S.E.(m) ±	2.48	0.22	1.18	0.33	2.02	63.55	153.71	1.84
C.D(P=0.05)	7.28	0.64	NS	0.97	NS	186.38	450.79	NS

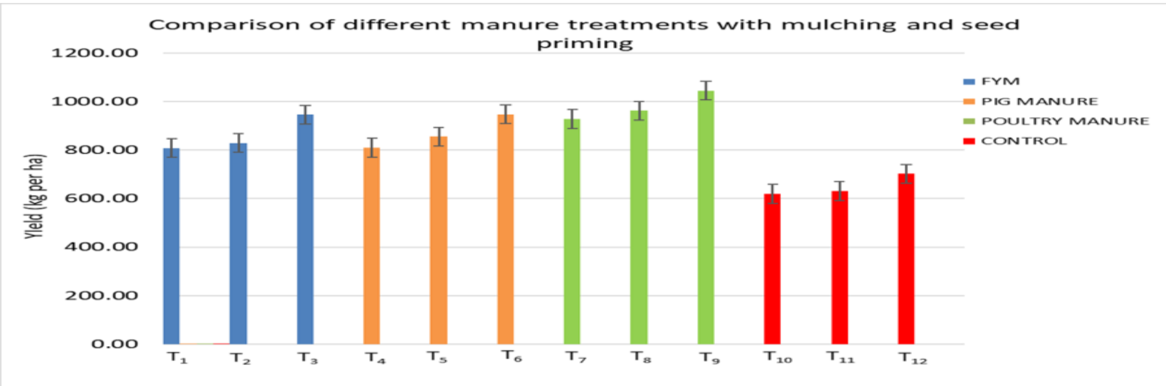

Figure 1. Effect of organic amendments on economic yield obtained under different treatments

weight was due to the interaction effect of organic amendments as described in above section stated by Gunasekar *et al.,* 2017

Non-significant results were obtained for the test weight under different treatment combinations. The maximum test weight (45.25 g) was recorded in T_9 as shown in the Table 2. This was deviating from the findings of Gunasekar *et al.,* 2017 and Kumar, 2006 because they reported that test weight varies significantly. The probable reason for non-significant result might be due to the genotype of that variety.

Grain yield and Stover yield

The economic yield in the Table 2. And in the Figure 1. Showed that the yield was greater in the treatments consisted of priming, mulching and manuring when compared to the yield obtained from control treatments similar to the seed weight per plant. As the grain yield depends on plant population, test weight, number of seeds per pod and number of pods per seed, the highest yield was obtained in the treatment consisted of poultry manure liquid wash, poultry manure incorporated along with maize stover mulch applied treatment (1,045.13 kg ha^{-1}). The treatment T_9 has a 69% of yield increase over the treatment T_{10}. While comparing all the treatments, the treatments consisted of all the three organic amendments recorded the maximum yield when compared with treatments consisted of mulching and manuring or only manuring. The yield increase was higher (49%) in poultry manure incorporated treatment of T_9 followed by FYM and pig manure incorporated treatments of T_3 (35%) and T_6 (35%). Application of mulch and manure has increased the yield up to 52% in T_8 of poultry manure, 36% in T_5 of pig manure and 31% in T_2 of FYM over the treatment T_{11} which consist of only mulch. Whereas application of manure alone has increased the yield upto 50% in poultry manure, 31% in pig manure and 30% in FYM over control (T_{10}). All the poultry manure incorporated treatments recorded the higher yield. This might be because of the greater availability of nutrients mobilized and solubilized by the organic acids produced by the organisms. It helps in better nutrient uptake and crop performance. This highest yield under mulching, priming and manuring was supported by the findings of Kumar, 2006; Gunasekar *et al.,* 2017 and Sharma and Abraham (2010). Significant result was recorded for the stover yield of black gram under different treatment combinations. The highest (2,430.48 kg ha^{-1}) stover yield was recorded in the treatment of seeds treated with poultry manure liquid wash, poultry manure incorporated along with maize stover mulch applied treatment. Higher shoot biomass obtained in poultry manure treatment might be attributed to the nutrient availability which enhanced the physiological metabolism of plants and influenced the dry matter production (Gyamfi, 2016). The trend of increase in dry matter accumulation from T_1 to T_9 shows that the continued availability of 2017.

manures (Sangeetha *et al.,* 2013). The higher yield under mulched treatments was due to the decomposition of organic materials and soil temperature maintenance which was favourable for the soil micro- nutrients might extend the leaf area duration, providing an opportunity to increase the photosynthetic rate, which enhanced the biomass production (Amanullah *et al.,* 2006). The difference might be due to the difference in accumulation of dry matter, number of pods per plant, number of seeds per pod. This was well agreed with the findings of Ulukan *et al.,* 2003.

Harvest index HI:

Harvest index (HI) was found non-significant among all the treatment combinations. HI is the ratio of economic (grain) yield to total biological (grain + stover) yield *i.e.* how much dry matter is converted into grain yield. The more dry matter production with the continued availability of nutrients increased the vegetative yield and resulted in non-significant HI. The similar result was obtained for Kumar, 2006 and Yasir *et al.,* 2014.

Benefit cost ratio

Gross return was found to be higher for T_9 (Rs. 82,831.87), T_8 (Rs. 77,687.54), T_6 (Rs. 77,447.82), T_3 (Rs. 76,533.32), T_7 (Rs. 74,879.98) and T_5 (Rs. 71,599.18) as shown in the Figure. 5.29. The higher net return was obtained for T_9 (Rs. 43,196.87) followed by T_7 (Rs. 41,394.86), T_8 (Rs. 39,973.76), T_6 (Rs. 36,685.07) and T_3 (Rs. 31,503.64) was shown in the Figure. 5.30. The higher BCR was obtained under poultry manure incorporated treatments (T_7 (2.24), T_9 (2.09), T_8 (2.06)) and the pig manure incorporated treatments (T_5 (1.56), T_4 (1.67), T_6 (1.69) and treatment with maize stover mulch (T_{11} (1.54)) recorded the lowest BCR. Similar findings under organic amendments were reported by Sutagundi, 2000; Sangeetha *et al*., 2013; Yadav and Lourduraj 2006; Choudhary and Bhambri, 2012; Gaire *et al.,* 2013; Inusah *et al.,* 2013; Parmar *et al.,* 2013; Tegen *et al,*. 2016.

4. Conclusion

While comparing the different combinations, the treatments consists of manuring + seed priming + mulching recorded the maximum in all the observations when compared to the treatment of only manuring and manuring + mulching. Therefore, organic amendments can be applied together and the yield will be also maximum. Also, accepting any treatment recommendation depends on its economic viability. It may be concluded that among the organic amendments treatments there is significant differences in the yield and in BCR therefore, poultry manure may be preferred over the other manures and seed priming with poultry manure liquid wash along with application of mulch has given the highest yield of 1045.13 kg ha^{-1}.

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Table 3. Effect of organic amendments on economics of black gram

Treatment combination	Cost of experiment (₹ha^{-1})	Gross return (₹ha^{-1})	Net return (₹ha^{-1})	BCR
T_1 - FYM	36,345.48	66,955.32	30,609.84	1.84
T_2 - FYM+ Mulch	38,626.58	69,009.31	30,382.73	1.79
T_3 - FYM+ SP (FYM L) + Mulch	39,848.25	76,533.32	36,685.07	1.92
T_4 - Pig manure	40,552.48	67,714.82	27,162.34	1.67
T_5 - Pig manure + Mulch	45,824.92	71,599.18	25,774.26	1.56
T_6 - Pig manure + SP (PM L) + Mulch	45,944.17	77,447.82	31,503.64	1.69
T_7 - Poultry Manure	33,485.12	74,879.98	41,394.86	2.24
T_8 - Poultry Manure + Mulch	37,713.78	77,687.54	39,973.76	2.06
T_9 - Poultry Manure + SP (PoM L) + Mulch	39,635.01	82,831.87	43,196.87	2.09
T_{10} – Control	29,174.50	51,614.97	22,440.47	1.77
T_{11} - Control + Mulch	34,160.48	52,634.76	18,474.29	1.54
T_{12} - Control + SP (Water) + Mulch	34,785.49	58,884.93	24,099.44	1.69
S.E.(m) ±		4,198.31	4,198.31	0.11
C.D(P=0.05)		12,312.11	12,312.11	0.34

6. References

Ali K, Munsif F, Uddin I, Khan AA, and N Khan, 2012. Maize penology as affected by tillage practices and nitrogen sources. *Agricultural Science Research Journal,* 2(8): 453-458.

Amanullah MM, Vaiyapuri K, Alagaesan A, Somasundaram E, Sathyamoorthi K, and S Pazhanivelan (2006). Effect of intercropping and organic manures on the yield and biological efficiency of cassava intercropping system (Manihot esculenta Crantz.) *Research Journal of Agricultural and Biological Sciences,* 2(5): 201-208.

Anbuselvi S, and JL Rebecca, 2013. GC-MS study of phyto chemicals in black gram using two different organic manures. *Journal of Pharmacy Research*, 1(1): 74-77.

Anonymous-I., 2017a. Commodity Profile for Pulses-March. http://agricoop.gov.in/sites/default/files/ Pulses%20profie%20for%20the%20month%20of% 20 November%2C%2 02017.pdf. Accessed on 5 April 2018.

Anonymous-I., 2017b. Statistical handbook of Meghalaya. Directorate of economics and statistical government of Meghalaya.megplanning.gov.in /handbook/ 2017 .pdf. Accessed on 28 March 2018.

Bandyopadhyay, S., 2016. Effect of Seed priming and foliar nutrition in Black gram. https://www. research gate. net/publication/309902335. doi: 10.13140/RG. 2.2. 16046.10567.

Bhanudas, J.M., 2010. Response of summer groundnut (*Arachis hypogea* L.) to land configuration and mulches under middle Gujarat conditions. M.Sc. (Agriculture) Thesis, submitted to Anand Agricultural University, (Gujarat) India.

Choudhary VK, and MC Bhambri, 2012. Agro-economic potential of capsicum with drip irrigation and mulching. SAARC *Journal of Agriculture,* 10(2): 51-60.

Das A, Babu S, Yadav GS, Ansari MA, Singh R, Baishya LK, Rajkhowa DJ, and SV Ngachan, 2016. Status and strategies for pulse production for food and nutritional security in north-eastern region of India. *Indian Journal of Agronomy,* 61: 43-57.

Dugesar V, Chaurasia AK, Bara BM, and K Kant, 2017. Effect of Different Priming Methods on Nodulation in Black gram (*Vigna mungo* L.) Seeds. *International Journal of Current Micro biology and Applied Sciences,* 6(7): 1137-1143.

Gaire R, Dahal KR, and LP Amgain, 2013. Effect of different mulching materials on weed dynamics and yield of direct seeded rice in Chitwan, Nepal. *Agronomy Journal of Nepal,* 3: 73-81.

Gerald W (2004). Role of rhizobium in nitrogen fixation and transfer in clover plants. *World Journal of Microbiology,* (13):81-83.

Gohain K O, Kumar S, and AL Jat, 2017. Protein yield and nutrient uptake of summer green gram [*Vigna radiata* (l.) Wilczek] as influenced by seed priming with plant geometry and nutrient management. *International Journal of Agricultural Sciences,* 9(49): 4832-4834.

Gomez KA and AA Gomez, 1984. Statistical procedure for agriculture research. 2nd Edn. International Rice Research Institute, Los Banos, Philipines. John Wily and Sons, New York. 324 pp.

Gunasekar, J., Kamaraj, A., and Padmavathi, S., 2017. Effect of pre-sowing seed priming treatment using botanical leaf extract on growth and yield characters in black gram (*Vigna mungo* [l.] Hepper) cv. CO 6. *Plant Archieves,* 17(2): 1013-1016.

Gupta HS, Sarna BK, and G Sahay,1998. Present status and prospects of pulse production in north eastern hill region. *Indian Journal of Hill farming,* 11(1& 2): 77- 87.

Gyamfi Y., 2016. Effects of NPK and poultry manure rates on the growth, nitrogen fixation and grain yield of soybean (*Glycine max* (L) Merrill). M.Sc. Thesis, submitted to Kwame Nkrumah University of Science and Technology, (Ghana) Africa.

Hamid A, Agata W, Maniruzzaman AFM, and AA Miah, 1991. Physiological aspects of yield improvement in mung bean. *In*: Advances in Pulses Research in Bangladesh. Procedings of the second national workshop on pulses. June 6-8, 1989, BARI, Gazipur-1701, Bangladesh. 95-102. pp.

Harris D, Raghuwanshi BS, Gangwar JS, Singh SC, Joshi KD, Rashid A, and PA Hollington, 2001. Participatory evaluation by farmers of on farm seed priming in wheat in India, Nepal and Pakistan. *Experimental Agriculture*, 37: 403-415.

Inusha BIY, Wiredu AN, Yirzagla J, Mawunya M, and H Mohammed, 2013. Effect of different mulches on the yield and productivity of drip irrigated onion under tropical conditions. *International Journal of Advance Agricultural Research,* 1: 133-140

Karmore JV., 2016. Integrated nitrogen management and seed priming effects on crop establishment, growth, yield and quality of winter maize (*Zea mays* L.). Ph.D. Thesis submitted to Indira Gandhi Krishi Vishwavidyalaya (Raipur), India

Kanto U, Jutamanee K, Osotsapar Y, Chai-arree W, and S Jattupornpong, 2014. Rice seed priming with swine manure extract to ameliorate vigor and nutrient status of seedlings. *Kasetsart Journal of Natural Sciences,* 48: 333 – 347.

Kumar P., 2006. Effect of mulching and plant population on growth and grain yield of black gram. M.Sc. Thesis, Submitted to Jawaharlal Nehru Krishi Vishwa Vidyalaya, (Jabalpur) India. Khurshid K, Iqbal M, Arif MS, and A Nawaz, 2006. Effect of tillage and mulch on soil physical properties and growth of maize. *International Journal of Agriculture and Biology*, 8(5): 593-596.

Maheshbabu HM, Hunje RNK, Patil B, and HB Babalad, 2008. Effect of organic manures on plant growth, seed yield and quality of soybean. *Karnataka Journal of Agricultural Sciences*, 21(2): 219-221.

Marwein Y., 2016. Influence of organic mulching on soil moisture and yield of rajma (*Phaseolus vulgaris* L.) varieties under mid altitude of Meghalaya. M.Sc. Thesis submitted to Central Agricultural University, (Imphal) India.

Nwokwu G and L Aniekwe, 2014. Impact of different mulching materials on the growth and yield of watermelon (*Citrullus lanatus*) in Abakaliki, Southeastern Nigeria. *Journal of Biology, Agriculture and Healthcare*, 4: 22-30.Parmer HN, Polara ND, and RR Viradiya (2013). Effect of mulching material on growth, yield and quality of watermelon (*Citrusllus lanatus* Thunb) Cv. Kiran. *Universal Journal of Agricultural Research,* 1(2): 30-37.

Pradhan V, Rai PK, Bara MB, and DK Srivastav (2017). Influence of halopriming and organic priming on germination and seed vigour in black gram (*Vigna mungo* L.) Seeds. *Journal of Pharmacognosy and Phytochemistry,* 6(4): 537-540.

Renuka Devi K, 2008. Physiological characterization of black gram (*Vigna mungo* (L.) Hepper) genotypes for high biomass and water use efficiency. Ph.D. Thesis, submitted to Acharya Ng Ranga Agricultural University, (Hyderabad) India.

Sangeetha SP, Balakrishnan A, and P Devasenapathy, 2013. Influence of organic manures on yield and quality of rice (O*ryza sativa* l.) and black gram (*Vigna mungo* l.) in rice-black gram cropping sequence. *American Journal of Plant Sciences*, 4: 1151-1157.

Sharma V and T Abraham, 2010. Response of black gram (*Phaseolus mungo*) to nitrogen, zinc and farmyard manure. *Legume Research,* 33(4): 295 – 298.

Surendar KK, Vincent S, Wanagamundi M, and H Vijayaraghavan, 2013. Physiological effects of nitrogen and growth regulators on crop growth attributes and yield of black gram (*Vigna mungo* L.). *Bulletin of Environment, Pharmacology and Life Sciences, 2*(4): 70-76.Sutagundi M., 2000. Effect of mulches and manures on growth and yield of chilli (*Capsicum annum* L.). M.Sc. (Agriculture) Thesis, submitted to the University Agricultural Sciences, (Dharwad) India

Tegen H, Dessalegn Y, and W Mohammed, 2016. Influence of mulching and varieties on growth and yield of tomato under poly-house. *Journal of Horticulture and Forestry,* 8(1): 1-11.

Ulukan H, Guler M, and S Keskin, 2003. "A path coefficient analysis some yield and yield components in faba bean (*Vicic faba* L.) genotypes. *Pakistan Journal of Biological Sciences,* 1951-1955.

Uwah DF, and GA Iwo, 2011. Effectiveness of organic mulch on the productivity of maize (*zea mays* l.) and weed growth. *The Journal of Animal and Plant Sciences*, 21(3): 525-530.

Wajid A, Ghaffar A, Maqsood M, Hussain M, and W Nasim, 2007. Yield response of maize hybrid to varying nitrogen rates. *Pakistan Journal of Agricultural Sciences,* 44(2): 57-75.

Yadav BK, and AC Lourduraj, 2006. Effect of organic manures and panchagavya spray on yield attributes, yield and economics of rice (*Oryza sativa* L.). *Crop Research,* 31(1): 1-5.

Yasir TA, Wasaya A, Bhutta ZM, Aatif HM, Farooq O, Ijaz M, Hussain S, Baloch AW, and M Muzammil, 2017. Seed bio-priming approach to amplify production potential of mungbean (*Vigna radiata* L.) in sandy soils. *Pure and Applied Biology*, 6(4): 1410-1416.