IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Impact of phosphorous and growth regulators on black gram: A review

Kodhati Vishnu

Department of Agronomy, School of Agriculture

Lovely Professional University, Jalandhar, Punjab, India (144411).

Abstract

Pulses are normally known as food legume while are secondary to cereals in production and utilization in India. Black gram [Vigna mungo (L) Hepper] otherwise called urd, or mash is one of the significant short duration pulse crop. The crop has its own significance because of high nutrition value of grains as human food and feed as rich feed for cattle. The grains contain around 24% protein on dry weight basis, which is more than twice than that of cereals. It is a decent green compost and erosion resistant cover crop. The crop likewise improves soil fertility by symbiotic fixation of atmospheric nitrogen in root nodules. As practices, a properly balanced supply of phosphorous and utilization of plant development controllers (PGRs) is one among the preeminent important factor to extend better returns in Black gram. Plant growth regulators (PGRs) assume a significant part in mitigating stress, increasing flower set, yield, and physiological proficiency of the crop. Many field experiments led on this crop from which it is regularly announced that the optimum level of phosphorous and growth regulators fundamentally upgraded the expansion, yield, and protein in crop. This paper mainly centres on the role of phosphorus and growth regulators of naphthalene acidic acid (NAA) and salicylic acid (SA) in improving the production of Black gram.

Keywords: Phosphorous, growth regulators, naphthalene acetic acid, salicylic acid, Black gram, growth and yield.

1.Introduction:

"PULSES" in Indian agriculture alludes to grain vegetables that are utilized as food as entire seed. Pulses are most significant food crops after cereals. India is biggest buyer and maker of pulses in world. Pulses are by and large gathering of 12 harvests incorporates pigeon pea, chickpea, moong, urad, lentils, khesari, beans and peas and so forth pulses are significant part of day by day menu of millions of individuals of the country. Pulses can be developed on wide scope of climatic and soil conditions. Pulse crop possess deep root system, biological nitrogen fixation, mobilization of insoluble soil nutrients and are called as soil fertility restores (Kumar et al., 2018). They contain high measure of proteins, fiber, nutrients and furthermore give amino acids. Pulse crop supply nutritious green fodder and feed for the domesticated animals. Pulses are primary source of proteins for vegetarians in India and praise the cereals in diet with proteins, fundamental amino acids, nutrients and minerals (Pingoliya et al., 2013). Pulses are good origin of vitamins like thiamine, niacin, riboflavin and minerals like phosphorous, calcium and iron (Venkidasamy et al., 2019). They contain 22 to 24% proteins, that are twice when contrasted with wheat and threefold that of rice (Shukla et al., 2013). Pulse assume vital part in remedying the lack of healthy sustenance, known to decrease a few non-transferable infections like colon malignant growth and cardiovascular illnesses (Jukanti et al.,2012). They are known "reco-usable" crops with an incredible situation in things like food, fertility and forage. Pulse are generally mainstream in many developing countries, becoming healthy diet in world (Reddy, 2013). India is world biggest grower of pulses accounting 27-28% of worldwide pulses production. Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and Karnataka are top five pulses delivering states in India. National Pulse Development Programme (NPDP) has been introduced by the government to increase the production and acreage of pulses. Total kharif pulses production during 2019-20 in India is 80.46 lakh tonnes (Anonymous: Data encryption standard (DES).

Black gram (Vigna mungo L.) is a widely grown grain legume and belongs to the family Fabaceae. According to Vavilov (1926), black gram originated in India, it is adopted to wide range of climatic conditions cultivated in almost all parts of India. It is referred as "King of the pulses" due its mouth watering taste and numerous other nutritional qualities. It be specific "Dal makhni" of Punjab and "Vada Sambhar" of south India, the taste rules the hearts of one and all alike.

Black gram is characterized in two groups Vigna mungo var. niger and Vigna mungo var. Virdis, in niger varieties invovle which develop early and have dark shaded seeds and in virdis varieties involve which develop late and their seeds are samller and green in shading. Equivalent word of Black gram is privately known as Urd, Biri and Mash. It is a yearly erect developing spice with tallness of 0.3-1.0 m and brown hairs are covered by stem. Leaves are trifoliate and dull green covered with lavish purplish little hairs. Black gram is self pollinated crop. Black gram is mainly grown in India as well as in Myanmar, Pakistan, Bangladesh and Srilanka. Involving both tropical and sub tropical locales. It has developed over 3.4 million hectare on the world, out of which 2.97 million hectare is filled in India. Black gram contributing 10% of the total pulse production from13% in absolute territory in India (Joshi, 2015). High estimations of lysine make urd bean a great supplement to rice as far as adjusted human nourishment (Sakila and Pandiyan, 2018).

Nutritive estimation of urdbean hold protein 26 - 27%, calcium - 154 mg/100g, fat-1.4%, phosphorus–385mg/100g, Minerals - 3.2%, Iron-9.1mg/100g, Fiber-0.9%, calorific worth 347Kcal/100g, carbohydrate60%, moisture10.9% and nutrients (mg/100gm) B1, B2 and Niacine 0.42, 0.37 and 2.0 separately (Panigrahi et al., 2014).

Black gram can be developed on various sorts of soils from light sandy to heavy clay soils having very much depleted condition. It needs to be temperature range between 25°C to 35°C, relative humidity 50 to 85% and yearly precipitation of 600-1000 mm for better development and improvement. However, it becomes better on rich dark vertisols or loamy soils with a pH 6-7. It can withstand acidic soil (down to pH 4.5). It is dry spell lenient and hence appropriate for semi bone-dry territories. Urd is delicate to saline and alkaline soils (Sharma et al., 2011). In rainfed farming, it has exceptional status, as it is a compelling soil blinder over all dirt protection and furthermore go about as green manuring crop. Black gram is a significant food vegetable with amazing source of good quality protein and having capacity to reestablish soil fertility through symbiotic nitrogen fixation (Gupta et al., 2008). India is bigger maker (25% of worldwide production), consumer (27% of word utilization) and importer (14%) of pulses in world. Pulses can be delivered with a base utilization of recourses and thus, it turns out to be less expensive even than creature protein. Significant states developing black gram in India all out territory (lakh ha) and production (lakh tonnes) of black gram is 44.78, 28.32 respectively in which Madhya Pradesh (12.03) (8.17), Utter Pradesh (6.44) (3.57), Andhra Pradesh (5.00) (3.29), Rajasthan (4.77) (3.05), Tamilnadu (4.30) (2.74), Maharashtra (3.38) (1.83), Gujarat, (1.97) (1.19), Jharkhand (1.57) (1.39), Orissa (1.09) (0.49) and Other states (3.29) (2.06) individually (Anon, 2016). In the year 2018–19 during rabi and 2019-20 during kharif in India area (lakh ha) and production (lakh tons) is 7.629, 26.5, 37.52 and 25.6, individually (Anon. 2019).

2. Discussion:

2.1 Role of phosphorous

Phosphorus (P) is the second fundamental macronutrient essential for the ordinary development and advancement of plants (Brady and Weil, 2008; Sanjay-Swami and Singh, 2020). Phosphorous play important role in root proliferation of pulse crop and there by atmospheric nitrogen assimilation. Phosphorous is constituent of ATP and ADP involved in metabolic and enzymatic reactions (Singh and Ali, 1994). P fertilization is the significant determinant of the mineral supplement yield in legume crops. Applied phosphorus incredibly influences the yield productivity of pulse crops (Nasreen et al., 2006; Sailo and Sanjay-Swami, 2019). It is a critical segment of nucleic acids, phospholipids and ATPs and assumes a part in various plant cell cycles like cell division, energy storage and transition, respiration, photosynthesis and enzymatic action. It includes the improvement of seedling, development of early roots, early heading arrangement and speeds up crop development (Alinajoati and Mirshekari, 2011). Plants likewise require phosphorus for development, sugar and starch use, photosynthesis, core arrangement, and cell division (Atif et al., 2014). Phosphorous is a important element demand in various function in growth and development of pulses. In most of the Indian soils it is a major limiting nutrient for growth of plant. Phosphorous add through fertilizer is used by the plants to some extent and large portion of its converted into insoluble fixed forms, in crops the phosphorous recovery efficiency is generally 10-30% (Swarup., 2002). Phosphorous solubilising bacteria (PSB) play crucial role in increasing P availability by solubilising the fixed P and supplying it to the plants in a more available form (Khan et al., 2007).

Effect of phosphorus in improving growth attributes of black gram

The result of the examination revealed that steady portion of phosphorus fundamentally affected the development qualities of black gram. Growth attributes, viz. plant stature, number of knobs plant, root length and shoot length were amplified by P treatment. Utilization of 75 kg P2O5 ha-1 recorded the greatest plant stature, nodulation, root and shoot length and was discovered to be genuinely comparable to 100 kg P2O5 ha-1. This ultimate impact of P fertilization on development excellence of black gram may be because of it desicive part in voluminous root improvement which facilitate the crop to passage water and minerals from more profound zones. In addition, P is needed for mitochondrial and symbiome film formation during nodule development to upgrade nitrogen fixation. Thus, the enhanced nutrient availability boosted up nutrient uptake which consequently prompts vigorous plant growth and development. These outcomes support with the discoveries of Singh et al., (2006), Bhuiyan et al., (2008), Rotaru et al., (2009), Kokani et al., (2013) and Tomar et al., (2013). Ganeshmurthy et al., 2003 concluded that response of urdbean to applied P at different locations varies from 60-90 kg p2o5 ha-1.

Effect of phosphorus in improving yield of black gram

Implementation of graded level of phosphorus essentially ameliorate the number of pods, dry matter production and grain yield of black gram. Phosphorus application @ 75 kg ha-1 keeps up predominance and was genuinely identical with 100 kg P2O5 ha-1. The auspicious result was expected to administrative capacity of P in photosynthesis that raises carbohydrate accumulation and sugar metabolism. It too organizes starch: sucrose proportion and administers legitimate activation of photosynthates that lead to expanded blossoming, fruiting, and seed development. The energy got from photosynthesis. This outcome was as per Bhattacharya and Pal (2001), Basu et al., (2003), Nadeem et al., (2004), Sepat et al., (2005), Biswas et al., (2009) and Khan et al., (2017). The grain and straw yield of chickpea improved by the application of 75kg p2o5 ha-1 followed by 50 kg P2o5 ha-1 (Dubey et al. (1990). Duraisamy and Mani (2000) and Prabakaran et al., (1999) showed that application of 40 kg P20S ha- 1 as rock phosphate combined with phosphobacteria and VAM produced increased grain and straw Yield of horsegram in Ragi-Horsegram sequence. Kamboj and Malik (2018) reported that increase in phosphorus and boron doses increases the seed yield of black gram with highest yield recorded on combined application of 100 mg P kg -1 along with 1.0 mg B kg-1.

2.1.1 Plant growth regulators:

Growth regulators can improve the physiological productivity including photosynthetic capacity and can upgrade successful dividing of the aggregates from source and sink in the field crops (Solaimalai et al., 2001). Foliar use of growth regulators and synthetic compounds at the blossoming stage may improve the physiological effectiveness and may assume a huge part in raising the productivity of the crop (Dashora and Jain, 1994). Plant growth regulators are synthetic substances that impact the development of plant at low concentration. Growth regulators assume key part in germination, vegetative development, blossoming, fruit development and physiological exercises in crop plants. It is perceived that by utilization of small quantity of growth regulators to foliar shower on plants the development conduct of numerous plants are controlled or changed. These are considered endogenous (biochemicals that delivered in plants) or manufactured which are applied exogenously. These are applied to improve the source-sink relationship, improve photosynthetic productivity, vegetative development and good pod development.

2.1.2 Salicylic acid:

Significance of Salicylic Acid (SA)

Salicylic acid has a place with an extra-common different gathering of plant phenolics. Salicylic acid is universally found in all plant species and the most elevated levels are seen in the inflorescence of thermogenic plants and in plants contaminated with necrotizing microbe (Raskin, 1992).

Salicylic acid is ortho-hydroxybanzoic acid which, as analogues of growth regulating substances, is an optional metabolite. It helps protect nucleic acids and counteract the degradation of proteins. The SA is also known to induce numerous genes for pathogenic proteins linked to biotic and abiotic stresses (Enyedi et al., 1992; Yalpani et al., 1994). The use of Salicylic acid as a foliar application increased the amount of IAA in broad bean leaves (Xin et al., 2000). Foliar utilization of SA applied a critical impact on plant growth metabolism when applied at physiological concentration, and consequently went about as one of the plant growth regulating substances (Kalarani et al., 2002).

Impact of salicylic acid on growth parameters

Salicylic acid (2-hydroxybenzoic corrosive), as a characteristic plant chemical, affects physiological cycles and growth of plants (Khan et al., 2010). In addition, salicylic corrosives have an important role to play in restoring some environmental concerns such as heat and drought (El-Tayeb, 2005). The use of salicylic acid (125 ppm) was shown by Jeyakumar et al. (2008), which increased the dry matter (21.6 grammes of plant) production in black gram. Nagasubramaniam et al (2007) have announced the expansion of the plant stature, leaf area, plant development rate and absolute dry matter generation in the foliar application of salicylic acid (100 ppm) for baby maize. Maity and Bera (2009) reported that foliar utilization of salicylic acid impacts diverse physiological and biochemical parts of green gram plant through increasing assimilation rate which revealed expanding in chlorophyll substance and Hill response action in the leaf.

Khan et al. (2003) announced that use of salicylic acid, acetyl salicylic acid and geninic corrosive improved the photosynthetic rate, stomatal conductance and transpiration rate in soybean. Sujatha (2001) reported that foliar use of salicylic acid (100 ppm) on green gram at °5 DAS expanded the plant stature (50. 4 cm), root length (16.9 cm), number of leaves (18. 4) and LAI (1.30).

Impact of salicylic acid on quality and yield parameters

Jeyakumar et al. (2008) announced that utilization of salicylic acid (125 ppm) in black gram expanded the seed yield (855 kg ha-'). Salicylic acid sprayed on mungbean fundamentally expanded the pod number plant and yield (Singh and Kaur, 1981). Sujatha (2001) detailed that foliar application of salicylic acid (100 ppm) on green gram at 75 DAS expanded number of pods\plant, number of seed\spod", seed weight\ plant, 100 seed weight and grain yield (840 kg ha-'). In green gram, foliar use of salicylic acid at branching, flower bud stages expanded the quantity of blossoms, pods and seeds\plant furthermore, seed yield (Singh et al., 1980). Jeyakumar et al. (2008) revealed that the highest seed protein content in black gram was recorded (24.5%) by foliar utilization of salicylic acid (125 ppm). Sujatha (2001) reported that foliar use of Salicylic acid (100 ppm) on green gram at 75 DAS expanded seed protein (23.98%) and soluble protein (12.9%). Kalpana (1997) found that foliar shower of salicylic acid expanded the solvent protein in rice. Foliar showers of salicylic corrosive in green gram expanded seed yield plant-1 (Singh et al., 1980). Furthermore, utilization of salicylic acid as a 100ppm fixation expanded number of pods plant-1, number of seeds per pod, and seed yield ha-1 (Sujatha, 2001). Jeyakumar et al. (2008) announced that use of 125 ppm salicylic acid to black gram expanded seed yield.

2.1.3 Naphthalene Acetic Acid:

Impact of NAA on growth and yield of black gram

The primary job of NAA rests with the efficient transport of sugars from photosynthesizing parts of the plant (source) to the creating grains (sinks) and furthermore working with nitrogen accumulation that most likely brought about higher complete dry matter production. Foliar spray of 25 ppm NAA recorded essentially higher seed yield by 21 to 22 percent over control through expanded bloom production, clusters per plant, pod setting rate and pods per plant in mungbean (Rajesh et al., 2014). NAA spraying was discovered to be huge in affecting the yield credits, for example, number of pods plant-1 (8.5 to 10.0), pod length (5.1 to 6.0 cm), number of seeds pod-1 (8.9 to 10.5) and 100 grain weight (2.9 to 3.0g) followed by MC at 50 ppm. Jayakumar et al. (2008) found that, NAA at 40 ppm given through foliage at pre flowering stage in black gram produced higher plant height (30.1 cm), a greater number of branches (2.3) and higher leaf area index (2.94). Utilization of N at 50 kg ha-1 and, NAA splashing enrolled the best return credits and yield anyway there was no huge contrast between their combinations (Kumar et al., 2004). The foliar application of NAA@ 10 PPM increased plant height reported by Jayaramireddy et al., (2004). Use of NAA expanded plant tallness, LAI, drymatter, chlorophyll and Nitrate Reductase Activity in blackgram. NAA @ 20 ppm was demonstrated essentially higher than 10 ppm. Further, NAA @ 20ppm decreased blossom drop and expanded the sink limit and yield (Lakshmamma and Subbarao, 1996). Subbaiah also, Chamy (1984) revealed that NAA prevents flower drop by preventing the development of abscission layer in blackgram and greengram. Seed nitrogen and protein content likewise expanded with NAA application.

The grain yield ranged from 717 to 1142 kg ha-1, when foliar showering of nutrient mix was given for the black gram, the treatment (2% DAP + 1% MOP + 40 ppm NAA at 25, 32, 40 and 47 DAS) recorded the most noteworthy mean grain yield of 1142 kg ha-1 followed by (2% DAP + 1% MOP + 40 ppm NAA at 25, 32, and 40 DAS) with a grain yield of 1044 kg ha-1. NAA @ (30 ppm) treatment was discovered to be effective to increment number of pods per plant, number of grains per case, dry matter and grain yield (q ha-1) (Ramanathan et al., 2004). The proof are given concerning NAA had positive impact on the dry matter collection in black gram, green gram and chickpeas (Ullah jafar et al., 2007). Also (karim MF 2005) has announced the finding of his examination that NAA had been discovered to be viable in expanding number of pods in cowpea, lablab bean, Pigeon pea and Chickpea. NAA @ (30 ppm) focus was discovered comparingly superior to other treatments and the branches expanded by NAA might be the reason to increase number of leaves (Kadam et al., 2009). The critical impact of NAA on biological yield 6393.77 kg ha-1 furthermore, 6543.85 kg ha-1 (2004-05) and 6466.38 kg ha-1 furthermore, 6552.38 kg ha-1 (2005-06) were recorded in control and plant growth regulator (NAA), separately. NAA gave an expansion of 2.35 furthermore, 2.87% in biological yield during 2004-05 and 2005-06, separately. Likewise harvest index was 37.63 and 41.69% during 2004-05 and 40.44 and 43.05% was recorded during 2005-06 in control and plant growth regulator (NAA), individually. As the harvest index depend on seed yield, NAA expanded pods per plant by diminishing blossom droppage and, accordingly improved 11.07% harvest index. Harvest index was expanded 11.07% by the use of NAA (Muhammad et al., 2010).

Comparative discoveries are likewise revealed by (Garish 2012) in his investigation and detailed that among the foliar showers, splash contained 2% DAP + 40 ppm NAA at 45 and 55 DAS recorded altogether higher seed yield (1202 kg ha-1) in black gram. The most elevated protein content (22.7%) was gotten with 2% DAPS + 1% K +20 ppm NAA (Shahikumar, 2012). The most elevated seed yield with NAA 20 ppm application can be ascribed to more incentive for the number of pods per plant (25.1), seeds per pod (7.0) and test weight (37.1 g) when compared to other treatments in green gram (Rajesh et al., 2014).

Rajesh et al. (2014) revealed that the morphological characteristics viz., plant stature, number of branches per plant, number of trifoliates per plant and days to half blossoming, absolute dry matter and development were essentially increased by NAA @ 20 ppm in green gram. Utilization of NAA at half blooming expanded plant tallness and dry weight that diminished the flower drop rate and prompted increment seed yield. Foliar use of NAA at 40 ppm at pre blooming stage in Black gram affected development qualities by appearing expanded plant stature, more number of branches and higher Leaf Area Index (Jayakumar et al., 2008). Sashikumar et al. (2013) announced in black gram that altogether higher growth components, for example, plant tallness (37.11 cm), number of branches (8.27 plant-1) were recorded with RDF + foliar splash of 40ppm NAA + 0.5% chelated micronutrient + 2% DAP over rest of the treatments.

3. Conclusion:

It is concluded that application of phosphorous and foliar spray of growth regulators like Naphthalene acetic acid (NAA) and Salicylic acid (SA) play an crucial role to increase the yield of Black gram. Phosphorous is considered as important component and has proven to be vital for the growth, development and productivity of Black gram. The optimum dose of phosphorous and plant growth regulators significantly enhanced the grain yield, protein content and early setting of 50% flowering and prolonged crop maturity besides significant improvement in the performance of various growth parameters, dry matter production and quality parameters of Black gram.

4. Reference:

Aslam Muhammad, Ahmad Ejaz, Saguu AG, Hussain Khalid, Ayaz Muhammad, Ullah Inayat et al (2010). Effect of plant growth regulator (NAA) and available soil moisture depletions on yield and yield components of chickpea. Sarhad J Agric. 26(3).

Atif MJ, Shaukat SA, Shah SZA, Choudhry YA, Shaukat SK (2014). Effect of different levels of phosphorus on growth and productivity of pea (Pisum sativum L.) cultivars grown as offseason under rawalakot azad Jammu and Kashmir conditions. J Recent Adv. Agric. 2(6):252-257.

Alinajoati SS, Mirshekari B (2011). Effect of phosphorus fertilization and seed biofertilization on harvest index and phosphorus use efficiency of wheat cultivars. J Food Agric. Environ. 9(2):388-397.

Anonymous. (2019). Production of black gram in India. Agriculture market intelligence center, PJTSAU, Directed of economic and statistics, ministry of agriculture and farmer Welfare, Govt. of India September, p. 1.

Anonymous (2016). Prospects of Pulses-2016 – NFSM www.nfsm.gov.in › Status Paper › Pulses.

Brady NC, Weil RR (2008). The Nature and Properties of Soils. 14th edition. Prentice Hall, Upper Saddle River, New Jersey, USA; 1104.

Biswas P, Bhowmick M, Bhattacharya A (2009). Effect of molybdenum and seed inoculation on nodulation, growth and yield in urdbean [Vigna mungo (L.) Hepper]. Journal of Crop and Weed. 5(1):141-144.

Bhuiyan M, Rahman M, Afroze F, Sutradhar G, Bhuiyan M (2008). Effect of phosphorus, molybdenum and Rhizobium inoculation on growth and nodulation of mungbean. J Soil. Nature. (2):25-30.

Basu M, Mondal P, Datta A, Basu T (2003). Effect of Cobalt, Rhizobium and Phosphobacterium Inoculations on Growth Attributes of Summer Groundnut (Arachis hypogaea Linn), Environment and Ecology. 21(4):813-816.

Bhattacharyya J, Pal A (2001). Effect of Rhizobium inoculation, phosphorus and molybdenum on the growth of summer greengram (Vigna radiata L. Wilczek). J Interacademicia. 5(4):450-457.

Duraisamy, P. and Mani, A.K. (2000). MysoreJ. Agric. Sci., 34: 340-345.

Dubey, S.K.etal (1990). Res. andDev. Reporter, 7: 32-36

Enyedi, A.J., N. Yalpani, P. Silverman and I. Raskin, (1992). Localization, Conjugation and function of salicylic acid in tobacco during the hypersensitive reaction to tobacco mosaic virus. Proc. Natl. Acad. Sci. USA.,89: 2480-2484.

Gupta S K, Souframanien J and Gopal, K. T. (2008). Construction of a genetic linkage map of black gram (Vigna mungo L. Hepper) based on molecular markers and comparative studies. Genome 51: 628-637.

Ganeshmurthy, A.N and Srinivasarao, Ch;Singh K.K. and Ali,M (2003). Management of phosphorous for high pulse productivity in different agroclimatic region of India. Ferti. News 48(6):23-41.

Jeyakumar, P., G. Velu, C. Rajendran, R. Amutha, M.A.J.R. Savery and S. Chidambaram, (2008). Varied responses of blackgram (Vigna munga) to certain foliar applied chemicals and plant growth regulators. Legume Res. Int. J., 31: 105-109.

Jeyakumar, P., G. Velu, C. Rajendran, R. Amutha, M.A.J.R. Savery and S. Chidambaram, (2008). Varied response of Black gram to certain foliar applied chemicals and plant growth regulators. Legume Res. Int. J., 31: 110-113.

Jayarami Reddy P, Narasimha Rao KL, Narasimha Rao CL, Mahalaxmi BK (2004). Effect of pre-sowing treatments with growth promoting chemicals and urea on seedling vigour, growth and yield of black gram in rice-fallow ecosystem. Annals of Plant Physiology. 18(2):108-112.

Joshi, M. (2015). The text book of field crops. 1 st Ed., Ashoke, K. Ghose PHI Learning private limited, Rimjhim House, 111 New Delhi -110092, p. 132

Jukanti AK, Gaur PM, Gowda CLL, Chibbar RN (2012). Nutritional quality and health benefits of chickpea (Cicer arietinum L.) a review. British Journal of Nutrition. 108: S11-S26.

Kadam GR, Kalyankar SV, Borgaonkar SB, Kadam BP (2009). Effect of sowing dates and NAA application on growth, development and yield in blackgram (Vigna mungo L.). International Journal of Plant Sciences. 3(2):567- 569.

Kumar, D., Singh, R., Somasundaram, J., Simaiya, V., Jamra, S. (2018). Effect of foliar application of nutrients on growth and development of blackgram [Vigna mungo (L.) Hepper] under rainfed Vertisols of Central India. International Journal of Chemical Studies. 6(1): 609-613.

Khan M.S., Zaidi, A and Wani, P.A. (2007). Role of phosphate- solubilizing microorganisms in sustainable agriculture- a review. Agronomy for sustainable development 27: 29-43.

Kokani J, Shah K, Tandel B, Nayaka P (2014). Growth, yield attributes and yield of summer blackgram (Vigna mungoL.) as influenced by FYM, phosphorus and sulphur, The Bioscan, 26:429-433.

Khan MMS, Singh VP, Kumar A (2017). Studies on Effect of Phosphorous Levels on Growth and Yield of Kharif Mung bean (Vigna radiata L. wilczek). International Journal of Pure and Applied Biological sciences. 5(4):800-808.

Khan, N.A., S. Syeed, A. Masood, R. Nazar and N. Iqbal (2010). Application of salicylic acid increases contents of nutrients and antioxidative metabolism in mung bean and alleviates adverse effects of salinity stress. Int. J. Plant Biol., Vol. 1.

Kalarani M.K., M. Thangraj, R. Sivakumar and V. Mallika (2002). Effect of salicylic acid on tomato productivity. Crop Res., 23:486-492.

Kumar Senthil N, Jayakumar R (2004). Effect of plant growth regulators on yield and quality of greengram (Vigna radiata L. Wilczek) under graded levels of nitrogen. Madras Agric. J. 91(1-3):92-95.

Khan, W., P. Balakrishnan and L.S. Donald, (2003). Photosynthetic responses of corn and soybean to foliar application of salicylates. J. Plant Phsiol., 160: 485-492.

Karim MF (2005). Physiological and biochemical responses of chickpea (Cicer arietenum L.) following application of fertilizers and growth regulators. Ph. D. Thesis. Department of Botany, Dhaka University, Bangladesh.

Lakshmamma P, Rao IVS (1996). Influence of shading and naphthalene acetic acid (NAA) on yield and yield components in blackgram (Vigna mungo L.). Annals of Agricultural Research. 17:320-321.

Maity, U. and A.K. Bera, (2009). Effect of exogenous application of brassinolide and salicylic acid on certain physiological and biochemical aspects of green gram (Vigna radiate L. Wilczek). Indian J. Agric. Res., 43: 194-199.

Marathe, Sushama A., et al. (2011). "Comparative study on antioxidant activity of different varieties of commonly consumed legumes in India." Food and Chemical Toxicology 49.9 2005-2012.

Nadeem MA, Ahmad R, Ahmad MS (2004). Effect of seed inoculation and different fertilizer levels on the growth and yield of mungbean (Vigna radiata L.). J agron. 3(1):40-42.

Nasreen S, Shil NC, Hossain MA, Farid ATM (2006). Effects of phosphorous and sulphur application on the yield and yield components of garden pea. Bangladesh J Agril. Res. 31(4):673-679.

Nagasubramaniam, A., G. Pathmamabhan and V. Mallika, (2007). Studies on improving production potential of baby corn with foliar spray of plant growth regulators. Ann. Plant physiol., 21: 154-157.

Panigrahi, K., Baisakh, B., Kar, M. and Mohanty, A. (2014). Research Note Genetic divergence in mutants and land races of black-gram [Vigna mungo (L.) Hepper] from Odisha. Electronic Journal of Plant Breeding, 5(3): 567- 572.

Pingoliya KK, Dotaniya ML, Mathur AK (2013). Role of phosphorus and iron in chickpea (Cicer arietinum L.). LAP LAMBERT Academic Publishing.

Prabakaran, J. et al (1999). Legume Res., 22: 137-138.

Rajesh K, Reddy Narender S, Reddy Kumar Pratap A, Singh Gopal B (2014). A comparative study of plant growth regulators on morphological, seed yield and quality parameters of Green gram. International Journal of Applied Biology and Pharmaceutical Technology. 5(3):103-109.

Rotaru V, Sinclair TR (2009). Interactive influence of phosphorus and iron on nitrogen fixation by soybean, Environmental and Experimental Botany. 66(1):94-99.

Raskin, I., (1992). Role of salicylic acid in plants. Ann. Rev. Plant Physiol. Plant Mol. Biol., 43: 439-463.

Ramanathan S, Natarajan K, Stalin P (2004). Effect of foliar nutrition on grain yield of rice fallow black gram. Madras Agric. J. 91(1-3):160-163.

Rajesh K, Narender Reddy S, Pratap Kumar Reddy A, Gopal Singh B (2014). A Comparative Study of Plant Growth Regulators on Morphological, Seed Yield and Quality Parameters of Green gram. International Journal of Applied Biology and Pharmaceutical Technology. 5(3):103-109.

Sakila, M. and Pandiyan, M. (2018). Realization of facts and profiteering of black gram through different breeding methods. Int. J. Chemi. Studies.6 (4): 3359-3369.

Sailo V, Sanjay-Swami (2019). Performance of pea (Pisum sativum L.) with residual phosphorus in phytoremediated heavy metal polluted soil of Jaintia hills, Meghalaya. Int. J Chem Studies. 7(3):3270-3273.

Singh R, Singh R, Yadav P, Singh S, Prasad L, Singh J (2006). Effect of sulphur and molybdenum on yield and quality of black gram (Vigna mungo L.), Crop Research-Hisar. 32(3):336.

Swarup. A (2002). Lessons from long term fertilizer experiments in improving fertilizer use efficiency and crop yields. Fertilizer news, 47(12); 59-73.

Sanjay-Swami, Singh S (2020). Effect of nitrogen application through urea and Azolla on yield, nutrient uptake of rice and soil acidity indices in acidic soil of Meghalaya. J Environ. Biol. 41(1):139-146.

Singh, G., N. Sekhon and K. Manjit, (1980). Effect of phenolic compounds on the yield potential of gram (Cicer arietinum L.). Ind. J. Plant Physiol., 23: 21-25.

Sujatha. K.B., (2001). Effect of foliar spray of chemicals and bioregulators on growth and yield of green gram.

Shashikumar R, Basavarajappa SR, Salakinkop, Manjunatha Hebbar, Basavarajappa MP, Patil HY (2013). Influence of foliar nutrition on performance of Blackgram (Vigna mungo L.), nutrient uptake and economics Under dry land ecosystems. Legume Research. 36(5):422-428.

Sujatha, K.B., (2001). Effect of foliar spray of chemicals and bioregulators on growth and yield of greengram (Vigna radiata L.). M.Sc. Thesis, Tamil Nadu Agric. Univ., Coimbatore.

Sepat S (2005). Response of mothbean [Vigna aconitifolia (Jacq.) Marechal] to phosphorus and sulphur fertilization under rainfed conditions. M. Sc. (Ag.) Thesis, Rajasthan Agricultural University, Bikaner.

Tomar TS, Kumar S, Tomar S (2013). Effects of plant density, nitrogen and phosphorus on black gram (Vigna mungo L. hepper), Annals of Agricultural Research. 34(4).

Ullah Jafar Md, Fattah Abdul Quazi, Hossain Feroza (2007). Response of growth, yield attributes and yield to the application of KNAP and NAA in cowpea (Vigna Unguiculata (L.) WALP.). Bangladesh J. Bot. 36(2):127-132.

Venkidasamy, B., Selvaraj, D., Nile, A.S., Ramalingam, S., Kai, G., Nile, S.H. (2019). Indian pulses: a review on nutritional, functional and biochemical properties with future prospective. Trends Food Science and Technology. 88: 228-242.

Xin, L., L. Yan and Z.S. Qui, (2000). Effect of salicylic acid on growth and content of IAA and IBA of broadbean seedlings. Plant Physiol., 2: 50-52.