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Review on foliar nutrition enhancing the growth and yield characters in Blackgram

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Abstract

Mungbean [*Vigna radiata* (L.) Wilczek] is an important crop in India and serves as a major source of dietary protein for majority of people. The nutritive value of mungbean lies in its high and easily digestible protein. The yield potential of blackgram is very low because of the fact that the crop is mainly grown in rainfed conditions with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factors *viz.*, insufficient partitioning of assimilates, poor pod setting due to the flower abscission and lack of nutrients during critical stages of crop growth, coupled with a number of diseases and pests were the reasons for the poor yield. The productivity of pulse crops in our country, including blackgram is not sufficient enough to meet the domestic demand of the population. Hence, there is need for enhancement of the productivity of blackgram by proper crop management practices.

Keywords: Mung bean, nutrients, crop growth, productivity

Introduction

Importance of foliar nutrition in pulse

Fertilizer is a vital input in agriculture to boost up the crop yields. Among the methods of fertilizer application, foliar nutrition is recognized as an important method of fertilization. Application of fertilizers on leaves of growing plants with suitable concentrations is termed as foliar application. In many cases aerial spray of nutrients is preferred and gives quicker and better results than the soil application (Jamal *et al.*, 2006). Foliar nutrients usually penetrate the leaf cuticle or stomata and enter the cells facilitating easy entry of nutrients. Foliar application is credited with remarkably rapid absorption and nearly complete utilization of nutrients, elimination of leaching losses and fixation and helps in regulating the uptake of nutrient by plants (Manonmani and Srimathi, 2009) [22].

Foliar feeding practice would be more useful in early maturing short duration crops, where the soil applied fertilizer may not become fully available before maturity of crop. As fertilizers application is complicated to apply through top dressing or placement, foliar fertilization is best suited for *rabi* pulses (Rahman *et al*., 2015) [26]. Under rice fallow situation, there is no possibility of basal application of fertilizer for pulses, since the pulses are sown prior to harvest of rice crop and fertilizer incorporation becomes impossible. Under these circumstances foliar application of nutrients would be more appropriate, efficient and economical than the soil application (Balusamy and Meyyazhagan, 2000) [5]. Foliar nutrition reduces the cost of cultivation which in turn reduces the amount of fertilizer thereby reducing the loss and also economizing the crop production.

Physiological problems like flower drop and premature shedding of reproductive structure diminishes the number of potential sinks and accumulation of assimilates (Writer, 1986) [38] which seems to be associated with nutrient deficiency and hormonal imbalance and ultimately translocation of dry matter to reproductive parts is reduced. The poor production potential of pulses is attributed to poor translocation of photosynthates to reproductive parts thereby decreased number of pods and seed setting. This situation may be improved through foliar application of macro and micronutrients and growth promoting substances.

Foliar application of fertilizers as a possible means of applying the needed nutrients for successful crop production is gaining considerable interest in recent years (Malarmathi and Thomas Abraham, 2003) [20]. This procedure improves nutrient utilization and lower environmental pollution through reduced amounts of fertilizers added to soil (Abou El-Nour, 2002) [1].

Foliar application is most effective when roots are incapable of absorbing required amount of nutrients from soil due to some reasons like high degree of fixation, lack of soil moisture, and losses from leaching and low soil temperature (Singh *et al*., 1970) [32].

Now-a-days, development of foliar fertilizers and their application techniques were suggested by numerous agri-agencies. Recently foliar application of nutrients has become an important practice in crop production while soil application of fertilizers is the basic method (Alam *et al.,* 2010) [2]. Foliar fertilization in terms of yield is more efficient than soil fertilization for both macro and micronutrients in different soil types (Ali *et al.,* 2008) [3]. Many plant nutrients are needed in such great quantities that it is impractical to supply them through the foliage. However, when soil conditions are unfavorable and micro-nutrients are needed to the plants, foliar applications may be accomplished for correction of nutrient level in plants.

Foliar application of N at particular stage may solve the slow growth, nodule senescence and low seed yield of pulse crops without involving root absorption at critical stage (Latha and Nadanassababady, 2003) [18]. According to Manivannan *et al*. (2002) [21] foliar application of N, P and K with chelated micronutrients has increased the grain yield of blackgram. Surendar *et al. (*2013) [33] studied the effect of basal application of nitrogen in combination with foliar spray of urea and plant growth regulators in blackgram. Among the various treatments studied, the basal application of nitrogen 25kg ha^{-1} with foliar spray of urea 2% and 0.1 ppm brassinolide significantly expressed the higher values in growth attributes *viz*., Leaf area index, Crop growth rate, Net assimilation rate and Specific leaf weight by showing higher accumulation of total dry matter production with increased yield.

Further, foliage applied micro and macro nutrients at critical stages of crops were efficiently absorbed and translocated to the developing pods, which generated much filled and more number of pods in soybean (Jayabal *et al.,* 1999) [12]. Thiyageshwari and Rangnanathan (1999) [36] studied the effect of foliar application of nutrients along with the recommended dose of nutrients on the dry matter production and yield of soybean. They reported that foliar application of NPK with $MnSo_4$, $ZnSo_4$, Sodium molybdate (0.05 per cent) and boron yielded the highest seed yield of 1832 kg ha^{-1} followed by foliar application of boron (1398 kg ha^{-1}) as against the recommended NPK (1225 kg ha^{-1}). Thangaraj (2000) [35] stressed the need for mixing foliar nutrients with growth regulators which will save a lot of time, energy and money. Foliar application of nutrient and growth regulator at pre flowering and flowering stage was seen on reduction in flower drop percentage in green gram. Foliar application of DAP 2 percent + NAA 40 ppm + $ZnSO_4$ 0.5percent + $FeSO_4$ 1 percent twice (Pre flowering + Flowering) + soil inoculation of phosphorous bacteria recorded significantly highest reproductive efficiency and grain yield of rice fallow pulses *viz*., blackgram and greengram (Ganapathy *et al.,* 2008) [11].

There are several advantages of foliar application of macro and micronutrients, liquid soluble fertilizers, growth promoters like amino acids, plant growth regulators and biofertlizers, however, some limitations were also reported. Those fertilizer materials suitable for foliar application must be soluble in water. Most of these are salts and when applied in too high concentration the solution will cause "burning" of the plant tissue. Often the safe concentration of the fertilizer material in the solution is so low that repeated applications are required to supply the needs of the plants. This is especially true of nitrogen, phosphorus and potassium (Singh *et al*., 2013) [32].

Effect of foliar application of nutrients on growth and physiology of crops

Plant height

Plant height is one of the important morphological growth parameter influenced by the applied nutrients and growth regulators. According to Dwivedi *et al.* (2014) [9] plant height (cm), dry matter accumulation (g plant-1), no. of branches (plant-1) and pods plant-1 were significantly higher (i.e. 70.88 cm, 17.09 g, 3.8 and 34.3 respectively) in blackgram under foliar spray of 15% K Sap + RDF than others treatments. Rajesh *et al*. (2014) [27] reported that the morphological traits *viz*., plant height, number of branches per plant, number of trifoliates per plant and days to 50% flowering, total dry matter and maturity were significantly increased by NAA @ 20 ppm in green gram. Application of NAA at 50% flowering increased plant height and dry weight that reduced the flower drop percentage and led to increase seed yield

Foliar application of NAA at 40 ppm at pre flowering stage in Blackgram influenced growth characteristics by showing increased plant height, more number of branches and higher Leaf Area Index (Jayakumar *et al.*, 2008) [13]. Sashikumar *et al*. (2013) [30, 31] reported in blackgram that significantly higher growth components such as plant height (37.11 cm), number of branches (8.27 plant-1) were recorded with RDF + foliar spray of 40ppm NAA + 0.5% chelated micronutrient + 2% DAP over rest of the treatments.

Bhattacharya *et al*. (2004) [6] studied the effect of balanced fertilization on pulse crop production in red and lateritic soils and reported that the plant height, chlorophyll content, dry matter production, and crop growth rate (CGR) of blackgram and greengram crops were significantly higher in the complete N,P,K,B, Mo treatment at 60 days after seeding (DAS).

Amin *et al*. (2013) [4] reported that Spraying of Put and IBA either individually or in combination significantly increased the plant height, number and dry weight of branches, leaves and pods/plant and leaf area/plant, total photosynthetic pigments at the two growth stages of chickpea. Li Yunsheng *et al*. (2015) [19] found that glutamine @ 25 ppm had a significant effect in the vegetative growth parameters of snap bean (plant height, number of leaves, number of branches, fresh and dry weight of leaves) in both the seasons of study compared to that of 100 ppm concentration

Foliar application of glutamine at 100-200 $mg \cdot L^{-1}$ significantly increased plant height, number of leaves, fresh weight of leaves, fresh and dry weight, leaf area, bulb length, bulb diameter and weight, as well as yield of onion and quality of bulbs (Amin *et al*., 2011). El- Zohiri and Asfour (2009) [10] found that spraying of amino acids at 0.25 ml L^{-1} on potato significantly increased vegetative growth expressed as plant height and dry weight of plant. Increased plant height with NAA @ 10 ppm in black gram was reported by Jayaramireddy *et al*. (2004) [14].

Crop Growth Rate (CGR)

Surendar *et al*. (2013) [33] reported that crop growth rate implied that both treatments registered increased values up to flowering stage to pod filling stage and the values decreased at pod filling stage to harvest stage. Among the treatments T_7 (N 25 kg ha ha-1 + Urea 2% + Brassinosteriod 0.1 ppm) was found effective in registering higher crop growth rate (0.78, 1.84 and 1.36 g m-2 day-1) than control (0.54, 1.22 and 1.02 g m-2 day-1).

Bhattacharya *et al*. (2004) [6] studied the effect of balanced fertilization on pulse crop production in red and lateritic soils and reported that the crop growth rate (CGR) of blackgram and greengram crops were significantly higher in the complete N, P, K, B, Mo treatment at 60 days after seeding (DAS).

Ramesh and ram Prasad (2013) [28] reported that the Mrophophysiological parameters, namely, Plant height, number of branches, number of trifoliates per plant, dry matter accumulation in leaf, stem and reproductive parts, LAI, CGR and RGR were significantly increased with the application of NAA (20 ppm) and brassinosteroid (25 ppm) in Soybean.

Leaf Area Index (LAI)

The leaf area was increased from vegetative stage to pod filling stage and declined thereafter. Among the treatments T_7 (N 25 kg ha ha-1 + Urea 2% + Brassinosteriod 0.1 ppm) performed its superiority and had higher leaf area (102.8, 246.1, 567.0 and 494.4 mg g-1) at vegetative stage, flowering stage, pod filling stage and harvest stage respectively. The LAI increased upto pod filling stage and declined in harvest stage of blackgram (Surendar *et al*., 2013) [33].

Application of NAA increased plant height, LAI, drymatter, chlorophyll and Nitrate Reductase Activity in blackgram. NAA @ 20 ppm was proved significantly higher than 10 ppm. Further, NAA @ 20ppm reduced flower drop and increased the sink capacity and yield (Lakshmamma and Subbarao, 1996) [17].

Leaf area (LA)

Datir *et al*. (2012) [7] reported that the unchelated micronutrient and amino acid treated chilli plants showed significant increase in plant height (9.83%, 10.49%), number of branches (21.97 and 23.48%) leaves per plant (19.89 and 21.02) and leaf area per plant (34.11 and 37.39%) respectively over control plants.

Sashikumar *et al*. (2013) [30, 31] reported in blackgram that significantly higher leaf area index (4.18), leaf area duration (60.45) and total dry matter production (15.98 g plant^{-1}) were recorded with (RDF + foliar spray of 40ppm NAA + 0.5% chelated micronutrient + 2% DAP) over rest of the treatments. Sayed *et al.* (2014) reported that all tested proline and tryptophan treatments enhanced leaf surface area of Manfalouty pomegranate in both seasons as compared with control treatment. Generaally, 100ppm tryptophan treatment was the alone treatment that induced positive significant effect in this respect. Other treatments produced a slight enhancing effect in this concern from the statistical standpoint.

Net assimilation rate (NAR)

Net assimilation rate was recorded at different phonological stages of the crop and significant differences were observed in all the treatments. The highest content of NAR recorded in the treatment of N 25 kg ha ha^{-1} + Urea 2% + Brassinosteriod 0.1 ppm (0.66, 0.65 and 0.63 mg cm-2 day^{-1}) at vegetative stage and flowering stage, flowering stage and pod filling stage, pod filling stage and harvest stage over control (Surendar *et al*., 2013) [33].

Effect of foliar application on biochemical parameters of Blackgram

Chlorophyll a, b and total chlorophyll

Higher level of chlorophyll-a, b and total chlorophyll in leaves were recorded in molybdenum treated plants in comparison to control. The significant and higher results for chl-a (0.093 mg g^{-1} fw), chl-b (0.090 mg g^{-1} fw) and total chl (0.348 mg g^{-1} fw) were obtained for treatment T_9 (7.5 ppm of Mo) (Datta *et al*., 2011) [8]. The stimulatory effect of 75 ppm boron applied through foliage on leaf chlorophyll content in broad bean and lupin plants was reported by Sharaf *et al*. (2009) [29]. Pegu *et al*. (2013) [25] reported that foliar feeding with 100 ppm boron caused increase in the amount of total chlorophyll in leaf. Foliar feeding was found to be more effective when it was done twice i.e. at 20 and 35 days after sowing**.** Sayed *et al.* (2014) reported that tryptophan treatments surpassed the corresponding ones of proline in enhancing leaf total chlorophyll content of Manfalouty pomegranate trees in both seasons. More- over, 100ppm tryptophan proved to be the superior treatment in this respect but without significant differences

Sugar content

Datta *et al*. (2011) [8] reported highest accumulation of sugar was found to be in treatment T_9 (7.5 ppm). There is variable rate of accumulation of ascorbic acid in different plant parts. Treatments T_6 (4.5 ppm) T_7 (5 ppm), T_8(6 ppm) showed significant and higher accumulation of ascorbic acid in root (5% for T_6; 5.03% for T_7 and 10.06% for T_8 respectively), shoot (1.57% for T_6; 1.78% for T_7 and 1.99% for T_8 respectively) and leaf (4.05% for T_6; 5.78% for T_7 and 7.60% for T_s, respectively) in comparison to other treatments. Higher accumulation was found to be in case of root and leaves.

Effect of foliar application on yield components and yield of Blackgram

Yield Components

Effect of foliar application of boron (B) on reproductive biology and seed quality of black gram (*Vigna mungo*) was studied by Pandey and Gupta (2013) [24]. Sashikumar *et al*. (2013) [30, 31] reported in blackgram that significantly higher significantly higher grain yield (1298kg ha-1) and number of pods/plant (38.73) were recorded with (RDF + foliar spray of 40ppm NAA + 0.5% chelated micronutrient + 2% DAP) over rest of the treatments. According to Maral *et al*. (2012) [23] foliar spray of amino acids (2 g L-1) showed the highest seed yield (1166.8 kg/ha), number of pods per plant (54.1) and plant height (69.5 cm) in cowpea

Kumar *et al*. (2013) [16] reported that foliar spray of 2% DAP twice at flowering and pod formation stages of soybean crop growth resulted in significantly higher number of pods plant^{-1} (62.75) than other foliar spray treatments. Molybdenum increased plant height, number of branches and pods per plant, number of seeds per plant and seed yield in lentil (Togay *et al*., 2008) [37]. It was found that molybdenum enhanced growth parameters, number of pods and seed yield in groundnut and chickpea (Khanal *et al*., 2009) [15]. Application of RDF + foliar spray of 40ppm NAA + 0.5% chelated micronutrient + 2% DAP i.e. T9 recorded significantly higher grain yield (1298 kg ha-1), number of pods/plant (38.73), number of seeds/pod (6.47) and test weight (61.90 g) over rest of the treatments in blackgram (Shashikumar *et al*., 2013) [30, 31]

Yield

Manivannan *et al.* (2002) [21] investigated that foliar application of N, P and K with chelated micronutrients had increased the grain yield of blackgram. Bhattacharya *et al*.

(2004) [6] reported adequate NPK fertilization increased green and blackgram yields by 13% and 38% over the control. Further inclusion of B and Mo improved yield by 38% for greengram and 50% for blackgram over the control. Tahir *et al.* (2014) [34] reported that Molybdenum (Mo) is an effective micronutrient that plays an important role in improving the crop yield and quality of black gram (*Vigna mungo* L.). Pegu *et al.* (2013) [25]**,** reported that physiochemical, root parameters and yield under rain fed situation during summer season in blackgram were influenced by foliar feeding with boron.

According to Manivannan *et al*. (2002) [21] foliar application of N, P and K with chelated micronutrients has increased the grain yield of blackgram. Foliar application of DAP 2 percent + NAA 40 ppm + ZnSO4 0.5percent + FeSO4 1 percent twice (Pre flowering + Flowering) + soil inoculation of phosphorous bacteria recorded significantly highest reproductive efficiency and grain yield of rice fallow pulses *viz*., blackgram and greengram (Ganapathy *et al.*, 2008) [11]. Similarly, foliar Spray of glutamine on growth, yield and quality of two snap bean varieties was reported by Li Yunsheng *et al*. (2015) [19]. Put and IBA increased the seed yield by 21.3 and 19.2%, respectively, while the combination of Putrescene at 100 mgL-1 and IBA at 50 mg L-1 increased it by 27.4%. Further, Put and IBA significantly increased the nitrogen, phosphorus, potassium, total soluble sugars and total free amino acids in chickpea seeds over control, but the effects were less marked than those of their combination (Amin *et al*., 2013) [4]. Surendar *et al*. (2013) [33] indicated that the treatment combination (N 25 kg ha-1 + BR 0.1 ppm + Urea 2%) was found to be the most effective treatment in improving the grain yield by 27 percent over control.

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