

**POST FLOWERING MANAGEMENT USING PLANT GROWTH REGULATORS
IN GREENGRAM(*Vignaradiata*L.)**

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ABSTRACT

Aim: The study was conducted to evaluate the effect of Auxin and ~~Zeatin-based~~ ~~Zeatin-based~~ nanoformulations in ~~post-flowering~~ ~~post-flowering~~ management in greengram.

Place and Duration of study: Nanoformulations were standardized at ~~the~~ Department of Nano Science ~~of~~ and Technology, Tamil Nadu Agricultural University, Coimbatore, and ~~a~~ field trial ~~was~~ ~~were~~ carried out at Agricultural Research Station, Bhavanisagar.

Methodology: Nanoformulations were standardized by oil in water nanoemulsion technique, and ~~the~~ effect on ~~a~~ crop is observed by foliar spray of nanoformulations during ~~the~~ flowering stage of crop growth.

Result: Increased chlorophyll content due to NAA and zeatin and extended retention of chlorophyll in Auxin-based treatments has been recorded. Hence the crop can produce more assimilates leading to increased seed yield. Zeatin spray also recorded increased chlorophyll, mature pods, number of seeds pod⁻¹, seed weight, pod setting percentage, and decreased flower shedding percentage.

Conclusion: Auxin and Zeatin plays a significant role in increasing plant chlorophyll content and yield of greengram. Among treatments, Nanoemulsion of NAA @ 30ppm recorded ~~a~~ higher number of mature pods, seed yield, seed weight, and lower flower shedding percentage, which is concluded as ~~the~~ best treatment.

Comment [H1]: The text could be written better in terms of grammatical rules. It is necessary to revise the entire text.

Keywords: ~~chlorophyll; Greengram; Naphthalene Acetic Acid, Post flowering management; Naphthalene Acetic Acid; yield attributes; Zeatin; chlorophyll; yield attributes~~

1. INTRODUCTION

Greengram (*Vigna radiata* L.) is a versatile crop ~~which is that is the~~ third most important pulse crop in India. Greengram is a good source of protein. The safe dietary reference intake of protein for an average human who weighs 75 kg is 56 grams per day, whereas the per capital availability of legumes in India is 43.8 grams per day which is much lower than the protein requirement of adults. Moreover, ~~A~~ yield gap of 48.73 percent ~~has been was~~ observed in 2019 which indicates a need of increase in production of greengram [16]. Possible ways to increase in the pulse production in India is by increasing area under pulses and raising the productivity of pulses per unit area of land [3]. Important way to increase pulse production is by maintaining crop during post flowering stage, as excess flower abscission lead to poor pod setting percentage eventhough the crop having excessive vegetative growth pattern and profuse flowering [31]. Flower as well as pod shedding is common feature in this crop which

is reflected in sink realization. Flower shedding is due to physiological, biochemical and also certain inherent factors associated with the crop. The physiological factors such as inefficient partitioning of assimilates, poor pod setting, excessive flower abscission and deficiency of nutrients during the critical stages of crop growth were found to be important yield barriers for greengram [1].

Post flowering management in pulses is an important practice to increase productivity. It is the activity carried out to reduce flower shedding, increase pod setting and thereby to increase yield. Foliar spray of nutrients and plant growth regulators has been carried out during 50% flowering and peak flowering stages. Growth regulators improve the physiological efficiency such as photosynthetic ability and enhance effective partitioning of assimilates from source and sink [33] and play a significant role in raising the productivity of the crop [7]. Foliar feeding of growth regulators is the most effective and economical way to improve plant nutrient need [8].

Auxins are plant hormones controlling plant growth and development at different environmental conditions [10]. Naphthalene Acetic Acid (NAA) is an aromatic acid which belongs to synthetic plant hormone of auxin family. It acts as a somatotrophin like growth regulator in plant system by stimulating cell division and elongation, membrane permeability, RNA synthesis, water uptake and in physiological processes such as prevention of fruit drop and bud sprouting, increase pod numbers, delay senescence, increase flower induction, fruit setting and also ultimately increase in yield [5].

Cytokinins are adenine derived plant growth hormones that are responsible for various plant metabolisms. Cytokinin delays senescence by delaying chlorophyll breakdown [21] and by reducing the mRNA leading to reduced protein levels of protease enzyme [15]. Zeatin is the first natural cytokinin isolated from maize [20]. Other than zeatin there are also various other forms of cytokinin such as adenine, kinetin (artificial aromatic cytokinin), 6-benzylamino purine (BA) and benzyladenine (natural aromatic cytokinin), thidiazuron and diphenyl urea (phenyl urea type cytokinin). Zeatin side chain contains a double bond and hydroxy group oriented in a *trans*- or *cis*-configuration representing *trans*-zeatin (tZ) or *cis*-zeatin (cZ), respectively [38]. Exogenous application [34] or increased exogenous production of cytokinins, overexpressing a senescence-associated gene specific promoter for driving the expression of the isopentenyl transferase gene delays senescence (Xu et al., 2010). Cytokinin found to increase sink strength in *Arabidopsis thaliana* [4] ultimately lead to higher yield.

Nano formulation is emerging technology for effective delivery mode of active molecules in agriculture due to its special features such as greater surface area, better wettability, and longer retention over the leaf surface facilitating the better uptake in plants. Nanoemulsions are those formed by very small emulsion nanoscale droplets (oil/water system) exhibiting size less than 100 nm [2,12]. Plant growth regulator in the form of nanoemulsion is a new way of approach in post flowering management in greengram.

2. MATERIALS AND METHODS

2.1 EXPERIMENTAL DETAILS

Field experiment was conducted at Agricultural Research Station, Bhavanisagar, Erode located at 11° 29' N latitude and 77° 80' E longitude to study the effect of Nanoformulated Auxin and Zeatin for reducing flower shedding in greengram. The variety of CO 8 greengram has been sown in spacing of 30x10 cm. Auxin and Zeatin nanoemulsion has been synthesized in department of Nano Science and Technology, TNAU, Coimbatore.

2.2 TREATMENT DETAILS

T₁ - Control

T₂ - Conventional formulation of NAA @ 40 ppm

T₃ - Nanoemulsion of NAA @ 20 ppm

T₄ - Nanoemulsion of NAA @ 30 ppm

T₅ - Nanoemulsion of NAA @ 40 ppm

T₆ - Conventional formulation of Zeatin @ 5 ppm

T₇ - Nanoemulsion of Zeatin @ 2 ppm

T₈ - Nanoemulsion of Zeatin @ 5 ppm

Convention NAA treatment has been imposed by dissolving NAA using 50 % of ethanol and Zeatin has been prepared by dissolving in 0.25 % DMSO. Spraying of conventional and nanoformulated Auxin and Zeatin has been carried out during 50 % flowering and peak flowering stages respectively.

2.3 OBSERVATIONS RECORDED

Changes in the chlorophyll content has been recorded by non-destructive method using SPAD chlorophyll meter reading (SCMR) both before and after spraying at 30th, 45th and 60th and 70th DAS. Yield parameters to demarcate the effect of growth regulators have been recorded in five tagged plants from each plot. Numbers of clusters, number of mature, immature pods, number of flowers, total number of seeds/plant are recorded in 5 tagged plants before harvest. Harvest has been carried out on 65 and 75 DAS as 1st picking and 2nd picking respectively to pursue clear idea about effect of growth regulators in yield of greengram. Picking of pods has been carried out and postharvest management practices have been followed.

Flower shedding count has been carried out every 3 days once from the day of spraying from tagged plants regularly. Pod setting percentage has been calculated from total number of pods formed which includes both mature and immature pods and total number of flowers formed which is been as calculated as mentioned above.

$$\text{Flower shedding percentage (\%)} = \frac{\text{Number of shed flowers}}{\text{Total number of flowers formed}} \times 100$$

$$\text{Pod setting percentage (\%)} = \frac{\text{Total number of pods formed}}{\text{Total number of flowers formed}} \times 100$$

2.4 STATISTICAL ANALYSIS

Data recorded were analysed using AGRES software. Grand mean, Critical difference (CD) at 5% level of probability, and standard error (SE_d) were analysed to find the significant difference between treatments. Parameters that exhibit no significant difference has been mentioned as NS.

Comment [H2]: What is the statistical design used?

UNDER PEER REVIEW

Table 1: Influence of conventional and nanoformulated NAA and Zeatin in SCMR value of greengram

| Treatment | SCMR (SPAD chlorophyll meter reading) | | | |
|---|---------------------------------------|-----------------------|------------------------|----------------|
| | Before spraying | 10Days After Spraying | 20 Days After Spraying | Before harvest |
| Control | 41.51 | 40.53 | 23.44 | 20.96 |
| Conventional NAA@ 40 ppm | 41.65 | 50.52 | 34.87 | 22.99 |
| Nanoemulsion of NAA @ 20ppm | 42.29 | 48.19 | 36.45 | 23.57 |
| Nanoemulsion of NAA @ 30ppm | 42.00 | 50.79 | 35.07 | 23.17 |
| Nanoemulsion of NAA @ 40ppm | 40.95 | 49.28 | 33.98 | 22.77 |
| Conventional formulation of Zeatin @ 5ppm | 42.65 | 45.27 | 26.79 | 22.79 |
| Nanoemulsion of Zeatin @ 2ppm | 40.37 | 49.99 | 25.47 | 22.48 |
| Nanoemulsion of Zeatin @ 5ppm | 39.48 | 49.79 | 24.7 | 21.22 |
| Grand mean | 41.36 | 48.04 | 30.20 | 22.44 |
| SE _d | 2.29 | 2.11 | 0.33 | 0.48 |
| CD (0.05) | NS | 4.52 | 0.78 | 1.13 |

Table 2: Influence of conventional and nanoformulated NAA and Zeatin based nanoemulsion in yield attributes of greengram

| Treatment | No of clusters | Numberof Immature pods | Number of Mature pods | Total number of pods formed | No of dropped flowers |
|---|----------------|------------------------|-----------------------|-----------------------------|-----------------------|
| Control | 17.13 | 8.49 | 31.76 | 39.73 | 49.38 |
| Conventional NAA@ 40 ppm | 23.00 | 28.33 | 48.46 | 79.43 | 39.07 |
| Nanoemulsion of NAA @ 20ppm | 20.40 | 11.81 | 50.26 | 58.85 | 34.95 |
| Nanoemulsion of NAA @ 30ppm | 22.47 | 24.36 | 73.61 | 93.25 | 27.18 |
| Nanoemulsion of NAA @ 40ppm | 20.40 | 17.48 | 55.84 | 69.79 | 32.54 |
| Conventional formulation of Zeatin @ 5ppm | 20.67 | 31.90 | 66.13 | 90.77 | 28.53 |
| Nanoemulsion of Zeatin @ 2ppm | 21.40 | 37.53 | 52.68 | 90.75 | 27.37 |
| Nanoemulsion of Zeatin @ 5ppm | 21.73 | 17.63 | 49.33 | 66.70 | 32.38 |
| Grand mean | 20.90 | 22.19 | 53.51 | 73.66 | 33.92 |
| SE _d | 1.62 | 3.15 | 4.00 | 3.36 | 2.02 |
| CD (0.05) | NS | 6.76 | 8.58 | 7.20 | 4.32 |

| Treatment | Flower shedding percentage (%) | Pod setting percentage (%) | Total no of seedsplant ⁻¹ | Seed weightplant ⁻¹ (gram) |
|---|--------------------------------|----------------------------|--------------------------------------|---------------------------------------|
| Control | 51.97 | 42.41 | 396.27 | 10.75 |
| Conventional NAA@ 40 ppm | 31.51 | 64.14 | 518.16 | 14.35 |
| Nanoemulsion of NAA @ 20ppm | 35.24 | 63.68 | 485.00 | 15.84 |
| Nanoemulsion of NAA @ 30ppm | 20.68 | 80.70 | 591.12 | 17.95 |
| Nanoemulsion of NAA @ 40ppm | 28.71 | 63.23 | 504.97 | 15.86 |
| Conventional formulation of Zeatin @ 5ppm | 21.11 | 71.20 | 526.56 | 16.92 |
| Nanoemulsion of Zeatin @ 2ppm | 23.67 | 73.63 | 520.24 | 14.73 |
| Nanoemulsion of Zeatin @ 5ppm | 37.64 | 69.27 | 485.07 | 10.64 |
| Grand mean | 31.32 | 66.03 | 503.42 | 14.63 |
| SE _d | 3.15 | 2.86 | 44.64 | 2.14 |
| CD (0.05) | 6.75 | 6.14 | 95.76 | 4.59 |

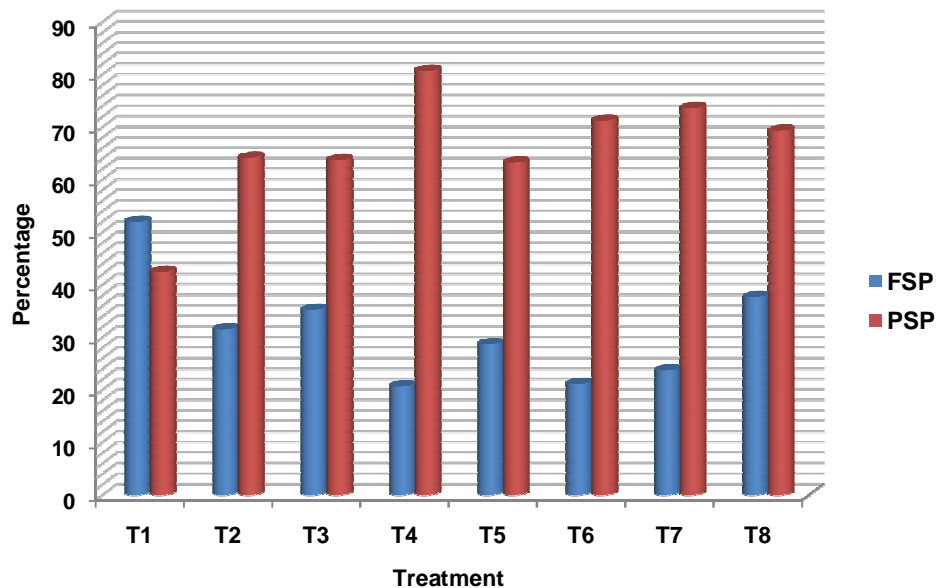


Fig. 1. Flower Shedding Percentage (FSP) and Pod Setting Percentage (PSP) of greengram after impose of treatments.

3. RESULT AND DISCUSSION

Chlorophyll pigment recorded before spraying expressed no significant difference whereas chlorophyll content after spraying of NAA and zeatin compared to control (Table 1). Chlorophyll pigment recorded before spraying is not significantly different among treatments but chlorophyll pigment recorded on 10 Days after Spraying clearly showed the effect of auxin and zeatin in increasing chlorophyll pigment. Among the treatments Nanoemulsion of NAA @ 30ppm(50.79) exhibit higher chlorophyll content followed by Nanoemulsion of Zeatin @ 2ppm(49.99) respectively. Similar results were recorded in brinjal [13] and soybean @ 40 ppm NAA [29] and in pearl millet [32] and cowpea [30] @ 20 ppm NAA. Increased chlorophyll content (1.61, 1.83 and 1.83) due to spray of kinetin @ at 0.01, 1.0 and 100 μ M compared to control (1.45) was observed during 35 DAS in Mungbean [9].

Chlorophyll content observed during 20 Days After Spraying also showed significant difference among auxin based treatments and zeatin based treatments. Effect of NAA in retaining chlorophyll content has been extended to a longer period compared to zeatin. Nanoemulsion NAA @ 30 ppm (36.45) found to be best among all other treatment in retaining chlorophyll pigment for long period compared to other treatments. NAA influenced chlorophyll content by preventing photooxidation of chlorophyll molecules [25, 26] due to maximum photosynthetic rate and higher leaf area caused by auxin. Similar results were observed in wheat by the effect of IAA @ 40 ppm [18] Maintenance of chlorophyll pigment

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with the exogenous application of zeatin ribose (ZR) is observed in creeping grass [13]. This clearly indicates that both auxin and zeatin plays a major role in increasing chlorophyll content thereby lead to increased photosynthetic accumulation. Chlorophyll recorded before harvest expresses on par in all treatments except nanoemulsion zeatin @ 5ppm and control.

Yield attributes (Table 2) of number of clusters is not significantly different among treatments, though numerical increase was observed compared to control in all other treatments. Effect of NAA in increasing no of clusters is recorded in blackgram [24]. Immature pods present before harvest showed significant difference among treatments. Nanoemulsion zeatin @ 2 ppm (37.53) gave the highest immature pods followed by Conventional formulation of Zeatin @ 5ppm (31.90). Control recorded very less immature pods (10.33) which may be due to increased flower shedding leading to decreased pod setting. Number of pods (mature and immature pods), number of seeds, seed weight and number of flowers during harvest were significantly influenced by the application of plant growth regulators compared to control.

Highest mature pods is recorded in Nanoemulsion of NAA @ 30ppm (73.61) compared to control (34.33). Total number of pods formed in plant is highest in Nanoemulsion of NAA @ 30ppm (93.25) and on par unit with Conventional formulation of Zeatin @ 5ppm (90.77). This finding was similar to that of NAA spray at 3 split doses on 45, 90 and 130 DAS recorded 11.5% increase in pod yield in chickpea [23]. The effect of cytokinin in increasing pod number in soybean was also proved which may be due to increased availability of assimilates to reproductive organ [36].

Spraying of Nanoemulsion of NAA 30@ ppm reduced flower shedding percentage and it was similar to Conventional formulation of Zeatin @ 5ppm. Highest flower shedding percentage was recorded in control. Similar finding was proved in blackgram with NAA application @ 5, 10 and 15 ppm respectively [19]. Reduced flower abscission (31.17, 32.26 and 31.89 percent) due to cytokinin was also recorded in lentil due to foliar application of kinetin @ 10, 20 and 40 ppm compared to control with flower shedding percentage of 40.28 percent [17].

Pod setting percentage showed superiority in Nanoemulsion of NAA @ 2ppm (80.70%) followed by Nanoemulsion of Zeatin @ 2 ppm (73.63%). Similar results were observed in soybean by NAA @ 10 ppm recorded 26 percent increased pod setting compared to control in soybean [25]. Benzyl Adenine applied to the racemes of soybean markedly increased the pod-set percentage in apical flowers of Essex and Shore varieties [6]. Flower shedding percentage and pod setting percentage has been presented in Fig. 1.

Total number of seeds per plant is higher in Nanoemulsion of NAA @ 30ppm(591.12)and it was comparative unit by Conventional formulation of Zeatin @ 5ppm(526.56). This might be due to increased number of pods in respective treatments. The research finding is correlated with the finding of increased number of pod and seed weight with the application of NAA @ 20ppm in soybean [28] and increased seed yield in blackgram through foliar spray of NAA @ 5, 10 and 15 ppm [19]. Effect of cytokinin in increasing seed yield due to increased sink strength has been reported in *Arabidopsis thaliana* [4]. Increased seed yield (3.83, 4.23 and 4.16) due to kinetin @ 0.01, 1 and 100 μ M compared control (3.73 g/plant) in greengram [9].

Higher seed weight (17.95) was observed due to application of Nanoemulsion of NAA @ 30ppm followed by conventional formulation of Zeatin @ 5ppm which was on par with all other treatments except control. Similar results was observed due to spray of NAA @ 20 ppm recorded higher seed weight (14.27g) compared to control in soybean (13.85) due to increased pods plant⁻¹ and seedspod⁻¹[28] and Kinetin @ 40 ppm and 10 ppm recorded increased seed weight in lentil [17].

4. CONCLUSION

Nanoemulsion of NAA @ 30ppm recorded higher chlorophyll content, clusters, number of pods plant⁻¹, no of seeds plant⁻¹, seed weight plant⁻¹, pod setting percentage and decreased flower shedding percentage. Hence, NAA nanoemulsion @ 30 ppm is best treatment among all other treatments in post flowering management.

REFERENCE

1. Alberda, Th, and JM W-de Boer. "Distribution of Dry Matter and Nitrogen between the Different Plant Parts in Intact and Depodded Soyabean Plants after Flowering." *Netherlands journal of agricultural science* 31, no. 2 (1983): 171-79.
2. Anton, Nicolas, and Thierry F Vandamme. "Nano-Emulsions and Micro-Emulsions: Clarifications of the Critical Differences." *Pharmaceutical research* 28, no. 5 (2011): 978-85.
3. Anu Lavanya, G, and M Ganapathy. "Effect of Dap, Naa and Residual Effect of Inorganic Fertilizers and Organic Manures on Growth and Yield of Greengram in Rice Based Cropping Sequence." *Journal of Agricultural Technology* 7, no. 3 (2011): 599-604.
4. Bartrina, Isabel, Elisabeth Otto, Miroslav Strnad, Tomáš Werner, and Thomas Schmülling. "Cytokinin Regulates the Activity of Reproductive Meristems, Flower Organ Size, Ovule Formation, and Thus Seed Yield in Arabidopsis Thaliana." *The Plant Cell* 23, no. 1 (2011): 69-80.
5. Basuchaudhuri, P. "1-Naphthaleneacetic Acid in Rice Cultivation." *Current Science* (2016): 52-56.
6. Crosby, Kevin E, Louis H Aung, and Glenn R Buss. "Influence of 6-Benzylaminopurine on Fruit-Set and Seed Development in Two Soybean, Glycine Max (L.) Merr. Genotypes." *Plant Physiology* 68, no. 5 (1981): 985-88.
7. Dashora, LD, and PM Jain. "Effect of Growth Regulators and Phosphorus Levels on Growth and Yield of Soybean." *Madras Agric. J* 81, no. 5 (1994): 235-37.
8. Dixit, Pradeep Mohan, and S Elamathi. "Effect of Foliar Application of Dap, Micronutrients and Naa on Growth and Yield of Green Gram (Vigna Radiata L.)." *Legume Research-An International Journal* 30, no. 4 (2007): 305-07.
9. Fariduddin, Q, A Ahmad, and S Hayat. "Responses of Vigna Radiata to Foliar Application of 28-Homobrassinolide and Kinetin." *Biologia Plantarum* 48, no. 3 (2004): 465-68.
10. Gomes, GLB, and KC Scortecci. "Auxin and Its Role in Plant Development: Structure, Signalling, Regulation and Response Mechanisms." *Plant Biology* (2021).
11. Grewal, MK. "Effect If Certain Growth Regulators on Physiology of Pod Filling in Moong (Vigna Radiata L. Wilczek)." *Punjab Agricultural Unviersity, Ludhiana*, 1985.

Comment [H5]: Due to the poor statistical analysis, the results could not be more reliable for reporting in journals; it is necessary to re-examine the results in terms of statistical analysis, then send the results for refereeing.

Comment [H6]: It is better to use up-to-date references; most of them are old references.

12. Gutiérrez, JM, C González, A Maestro, IMPC Solè, CM Pey, and J Nolla. "Nano-Emulsions: New Applications and Optimization of Their Preparation." *Current opinion in colloid & interface science* 13, no. 4 (2008): 245-51.
13. Hoque, AKM Ariful, Quazi Maruf Ahmed, Md Moshir Rahman, and Md Ashraf Islam. "Effect of Application Frequency of Naphthalene Acetic Acid on Physiomorphological Characters and Yield of Brinjal." *Research in Agriculture Livestock and Fisheries* 5, no. 2 (2018): 151-55.
14. Hu, Shanshan, Yanfei Ding, and Cheng Zhu. "Sensitivity and Responses of Chloroplasts to Heat Stress in Plants." *Frontiers in plant science* 11 (2020): 375.
15. Jiang, Wei Bo, Amnon Lers, Ella Lomaniec, and Nehemia Aharoni. "Senescence-Related Serine Protease in Parsley." *Phytochemistry* 50, no. 3 (1999): 377-82.
16. Khairnar, KY, VG Pokharkar, SA Kadam, and DB Yadav. "Green Gram Production Technology: An Economic Analysis." *Journal of Pharmacognosy and Phytochemistry* 8, no. 3 (2019): 2491-94.
17. Khalil, S, HM El-Saeid, and M Shalaby. "The Role of Kinetin in Flower Abscission and Yield of Lentil Plant." *J Appl Sci Res* 2 (2006): 587-91.
18. Kumar, Vivek, and SP Kushwaha. "Effect of Exogenously Applied Growth Regulators on Morpho-Physiological and Biochemical Attributes of Wheat (*Triticum Aestivum* L.)." *Journal of Pharmacognosy and Phytochemistry* 9, no. 4 (2020): 1045-51.
19. Lakshamma, and V Subbarao. "Response of Blackgram (*Vigna Mungo* L.) to Shade and Naphthalene Acetic Acid." *Indian J. Plant Physiol.*, (1996).
20. Letham, David Stuart. "Cytokinins from Zea Mays." *Phytochemistry* 12, no. 10 (1973): 2445-55.
21. Martin, Colin, and Kenneth V Thimann. "Role of Protein Synthesis in the Senescence of Leaves: Ii. The Influence of Amino Acids on Senescence." *Plant Physiology* 50, no. 4 (1972): 432-37.
22. Mooney, Sutton. "Characterization of the Arabidopsis Thaliana Auxin F-Box Family Members Afb4 and Afb5." Indiana University, 2007.
23. Muhammad, Aslam, Ahmad Ejaz, AG Sagu, Hussain Khalid, Ayaz Muhammad, Ullah Inayat, and Hussain Amir. "Effect of Plant Growth Regulator (Naa) and Available Soil Moisture Depletions on Yield and Yield Components of Chickpea." *Sarhad Journal of Agriculture* 26, no. 3 (2010): 325-35.
24. Patil, SN, RB Patil, and YB Suryawanshi. "Effect of Foliar Application of Plant Growth Regulators and Nutrients on Seed Yield and Quality Attributes of Mungbean (*Vigna Radiata* (L) Wilczek)." *Seed research-New Delhi* 33, no. 2 (2005): 142.
25. Phanophat, Nonglak, Rattanaphon Phromsattha, and Suchada Chokworawatthanakon. "Effects of Naphthalene Acetic Acid [Naa] on Yield and Quality of Soybean [in Thailand]." *Phytochemistry* 12, no. 10 (1973): 2445-55.
26. Prakash, M, J Siddesh Kumar, K Kannan, M Senthil Kumar, and J Ganesan. "Effect of Plant Growth Regulators on Growth, Physiology and Yield of Blackgram." *Legume Research-An International Journal* 26, no. 3 (2003): 183-87.
27. Ramesh. R, and Reddy. DVV. "Synergistic and Inhibitory Effects of Plant Growth Regulators on Soybean (*Glycine Max* L. Merrill)." *Helix* 4 (2013).
28. Rajesh, K, S Reddy, APK Reddy, and BG Singh. "Effect of Plant Growth Regulating Compounds on Chlorophyll, Photosynthetic Rate and Yield of Green Gram." *International Journal of Development Research* 4 (2014): 1110-12.
29. Senthil, A, G Pathmanaban, and PS Srinivasan. "Effect of Bioregulators on Some Physiological and Biochemical Parameters of Soybean (*Glycinemax* L.)." *Legume Research-An International Journal* 26, no. 1 (2003): 54-56.

30. Shinde, AK, and BB Jadhav. "Influence of Naa, Ethrel and Kno3 on Leaf Physiology and Yield of Cowpea." *Ann. Plant Physiol* 9 (1995): 43-46.
31. Singh, Gurbaksh, and Manjit Kaur. "Effect of Growth Regulators on Podding and Yield of Mung Bean (*Vigna Radiata* (L.) Wilczek)." *Indian J. Plant Physiol* 23 (1980): 366-70.
32. Sivakumar, R, G Pathmanaban, MK Kalarani, Mallika Vanangamudi, and PS Srinivasan. "Effect of Foliar Application of Growth Regulators on Biochemical Attributes and Grain Yield in Pearl Millet." *Indian Journal of Plant Physiology* 7, no. 1 (2002): 79-82.
33. Solaimalai, A., C. Sivakumar, Sadasivam Anbumani, T. N. Suresh, and K. Arulmurugan. "Role of Plant Growth Regulators in Rice Production@ a Review." *Agricultural Reviews* 22 (2001): 33-40.
34. Taverner, E, D Stuart Letham, Jun Wang, E Cornish, and DA Willcocks. "Influence of Ethylene on Cytokinin Metabolism in Relation to *Petunia* Corolla Senescence." *Phytochemistry* 51, no. 3 (1999): 341-47.
35. Xu, Yan, Thomas Gianfagna, and Bingru Huang. "Proteomic Changes Associated with Expression of a Gene (*Ipt*) Controlling Cytokinin Synthesis for Improving Heat Tolerance in a Perennial Grass Species." *Journal of experimental botany* 61, no. 12 (2010): 3273-89.
36. Yashima, Yumi, Azusa Kaihatsu, Takayuki Nakajima, and Makie Kokubun. "Effects of Source/Sink Ratio and Cytokinin Application on Pod Set in Soybean." *Plant Production Science* 8, no. 2 (2005): 139-44.
37. Yoshida, Saiko, Shunsuke Saiga, and Dolf Weijers. "Auxin Regulation of Embryonic Root Formation." *Plant and cell physiology* 54, no. 3 (2013): 325-32.
38. Zürcher, E, and B Müller. "Cytokinin Synthesis, Signaling, and Function—Advances and New Insights." *International review of cell and molecular biology* 324 (2016): 1-38.