Original Research Article

# POST FLOWERING MANAGEMENT USING PLANT GROWTH REGULATORS IN GREENGRAM *(Vigna radiata* L.)


## ABSTRACT

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

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

**Methodology:** Nanoformulations were standardized by oil in water nanoemulsion technique and effect on crop is observed by foliar spray of nanoformulations during 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 higher number of mature pods, seed yield, seed weight and lower flower shedding percentage which is concluded as best treatment.



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


## 1. INTRODUCTION

Greengram (*Vigna radiata* L.) is a versatile crop which is 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 gram per day, whereas the per capital availability of legumes in India is 43.8 gram per day which is much lower than the protein requirement of adults. Moreover, Yield gap of 48.73 percent has been 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 improves the physiological efficiency such as photosynthetic ability and enhances effective partitioning of accumulates from source and sink [33] plays 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 regulators 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, delays 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 proteases 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

$T_1$ - Control

$T_2$ - Conventional formulation of NAA @ 40 ppm

$T_3$ - Nanoemulsion of NAA @ 20 ppm

$T_4$ - Nanoemulsion of NAA @ 30 ppm

$T_5$ - Nanoemulsion of NAA @ 40 ppm

$T_6$ - Conventional formulation of Zeatin @ 5 ppm

$T_7$ - Nanoemulsion of Zeatin @ 2 ppm

$T_8$ - 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 30$^{th}$, 45$^{th}$ and 60$^{th}$ and 70$^{th}$ 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 1$^{st}$ picking and 2$^{nd}$ 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.

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

| Treatment | SCMR (SPAD chlorophyll meter reading) | | | |
|---|---|---|---|---|
| | Before spraying | 10 Days 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 | Number of 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 seeds plant$^{-1}$ | Seed weight plant$^{-1}$ (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 |

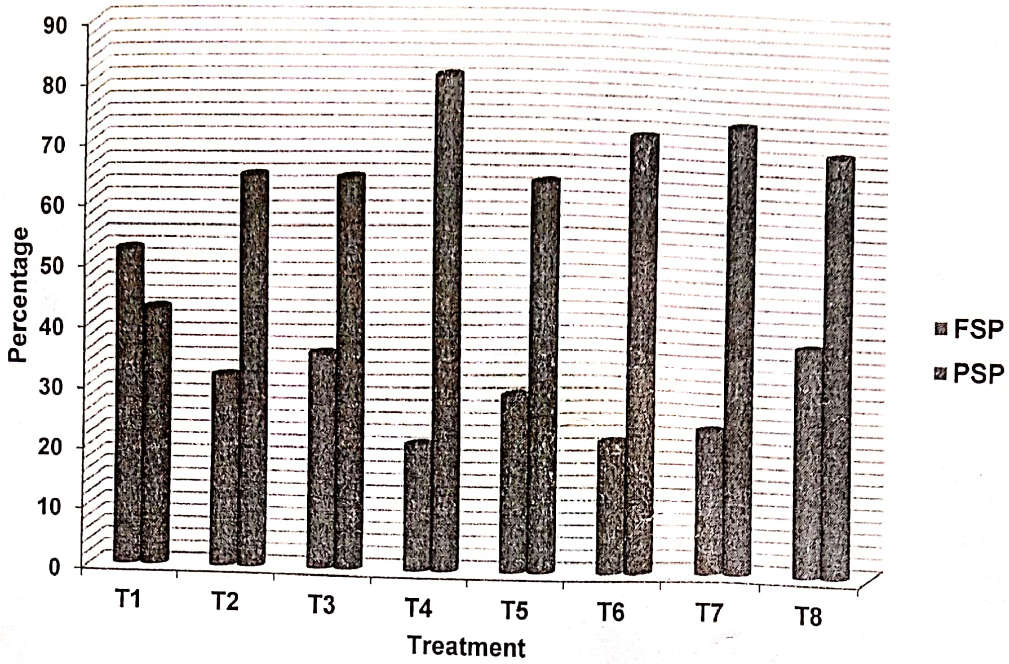


Fig. 1. Flower Shedding Percentage (FSP) and Pod Setting Percentage (PSP) of greengram after impose of treatments.

## 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 μM 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 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 recoded 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 µM 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 seeds pod$^{-1}$ [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.

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