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# Effect of Nutrio - Hormonal Consortia on Growth and Yield in Groundnut

**Tatiparthi Praisy [a++], R. Sivakumar [a#*], D. Vijayalakshmi [a#], R. Sasikala [b†] and R. Karthikeyan [a‡]**

*[a] Department of Crop Physiology, AC&RI, TNAU, Coimbatore, India.*
*[b] Department of Oilseeds, AC&RI, TNAU, Coimbatore, India.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

This study addresses a knowledge gap in understanding the interaction effect of nutrient-plant growth regulators on groundnut which plays a vital role in morpho-physiological processes for achieving enhanced productivity. The main goal was to evaluate how different nutrio-hormonal combinations affect groundnut traits. The experiment was conducted in pot culture at glasshouse, Department of Crop Physiology, TNAU, Coimbatore, utilizing a factorial completely randomized design. Two genotypes, BSR 2 and VRI 8, received five treatments with four replications: $T_1$ - control (foliar water spray), $T_2$ - Nutrio hormonal consortia 1, $T_3$ - Nutrio hormonal consortia 2 ($T_2$ + $K_2SO_4$), $T_4$ - Groundnut booster 1 ($FeSO_4$, $K_2SO_4$, $MgSO_4$, Borax), and $T_5$ - Groundnut booster 2 ($T_4$ + Salicylic acid + NAA-Naphthalene Acetic Acid). Application of $T_5$ to VRI 8 showed significant results, with higher leaf area (2297.83 $cm^2$) and specific leaf weight (19.87 $mg/cm^2$) where as BSR 2 had smaller leaf area (872.86 $cm^2$) and higher specific leaf weight (51.55 $mg/cm^2$). VRI 8 had

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[++]*PG Research Scholar;*
[#]*Professor;*
[†]*Assistant Professor;*
[‡]*Associate Professor and Directorate;*
**Corresponding author: E-mail: sivakumar.r@tnau.ac.in;*

fewer pods but higher yield (8.16 g/plant) than BSR 2 (7.07 g/plant). In conclusion, the foliar application of $T_5$ - Groundnut booster 2 with the VRI 8 variety holds promising potential for enhancing groundnut yield.

*Keywords: Groundnut; nutrients; salicylic acid; NAA; BSR 2; VRI 8; growth; yield.*

## 1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a vital oilseed crop grown mainly in the summer across 108 countries in tropical and subtropical areas. It is a significant staple legume with economic and nutritional benefits. Many small-scale farmers value this crop. About two-thirds of its global production is used for oil, while the remaining one-third is a dietary staple. Belonging to the Leguminosae family, it's often called the "Poor Man's Almond," contributes substantially to the agricultural landscape [1]. In India, groundnut covers 40% of the total area for oilseed cultivation and makes up 60% of the total production. Kernels have around 44-50% oil, 26% protein, and 10-20% carbohydrates. They're also rich in essential nutrients like Vitamin E, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine, and potassium, in significant amounts. The oil from groundnut seeds is used for cooking. After extracting the oil, the leftover material, called oil cake, is valuable. It contains about 7-8% nitrogen (N), 1.5% phosphorus pentoxide ($P_2O_5$), and 1.2% potassium oxide ($K_2O$). This material can be repurposed as a nutrient-rich organic fertilizer [2].

Potassium is a vital nutrient for plants, increasing crop yield and stress tolerance. It's crucial for the growth assimilation, transport, and storage of tissue development. Groundnut absorbs potassium, aiding in various processes like water status maintenance, energy synthesis, and pod growth. Sulphur is the fourth major nutrient and is important in the nutrition of oil-seed crops, as well as a constituent of the sulphur-containing amino acids like cysteine, and methionine. They hypothesized that oil-seeds require more sulphur than other crops, and that its concentration and uptake vary with soil sulphur availability [1].

Mg supplementation in groundnut resulted in increased pod yield. The increase was due to greater no of pods/plant, and pod weight (g/plant) as a result of improved root growth and nodulation. It has a significant impact on groundnut growth and production [3]. Boron is crucial for groundnut growth, influencing pollen germination, growth, and fruit development. It's essential for various physiological processes like carbohydrate metabolism, protein synthesis, and seed development, maintaining optimal flowering patterns and fruit development [4].

Iron deficiency affects nutrient quality and crop productivity. Iron plays a role in chlorophyll production, active compounds in plants, and metal-binding proteins. Its involvement in biochemical processes highlights its importance in plant physiology and function, potentially enhancing groundnut yields [2]. The purpose of this study was to determine the effect of different levels of nutrients with plant growth regulators on groundnut yield and quality.

## 2. MATERIALS AND METHODS

The current research was conducted primarily to investigate the physiological basis of yield improvement in groundnut by nutrio-hormonal consortia. The research was carried out in pot culture at the Department of Crop Physiology, TNAU, Coimbatore. Five treatment combinations comprising $T_1$ - control (foliar water spray), $T_2$ - Nutrio hormonal consortia 1, $T_3$ - Nutrio hormonal consortia 2 ($T_2$ + $K_2SO_4$), $T_4$ - Groundnut booster 1 ($FeSO_4$, $K_2SO_4$, $MgSO_4$, Borax), and $T_5$ - Groundnut booster 2 ($T_4$ + Salicylic acid + NAA-Naphthalene Acetic Acid) were tried in factorial completely randomized design with four replications. The seeds of Groundnut (*Arachis hypogea* L) genotypes BSR 2 and VRI 8 were collected from the Department of Oil seeds, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Groundnut seeds were treated with talc formulation of *Trichoderma viridae* @ 4g/kg of seed. Pots were filled with a mixture of red soil, sand and farmyard manure in 3:1:1 ratio. Seeds (3 to 4 number) were placed in a pot containing pot mixture and life irrigation was given. Thinning and gap- filling were carried out seven days after germination. Recommended crop management and plant protection measures are followed during the crop growth stage as per TNAU Crop production guide. At the flowering stage, the plants were sprayed with different treatments. Plants sprayed with water are treated as control.

Physiological parameters were observed at 15 days after spraying. NDVI is related to leaf area, leaf angle, leaf color, leaf thickness, and leaf moisture. The average values of NDVI were recorded by a hand-held green seeker (optical sensor), placed and run with a triggering button pressed 60-65 cm above the crop canopy. The total leaf area was measured using a Leaf Area Meter (LICOR, Model LI 3000), and the results were expressed as $cm^2$ $plant^{-1}$. Specific leaf weight is the ratio of leaf dry weight to its assimilating surface area. SLW is calculated by the formula of Pearce *et al.* (1968) and the results are expressed in mg $cm^{-2}$.

$$SLW = \frac{\text{Leaf dry weight/plant}}{\text{Leaf area/plant}}$$

For total dry matter production, plant samples were uprooted, the root portion were washed, shade dried and then oven dried at 80 °C for 48 hrs. The dry weight of the whole plant was recorded and expressed as g $plant^{-1}$. Yield and yield components were recorded at the harvesting stage. The number of pods per plant was taken randomly from three different plants in control and treatments and the results are expressed in the number of pods $plant^{-1}$. Pod yield was recorded in control and various treatments, the results are expressed in g $plant^{-1}$. The data collected from the pot culture experiment on various parameters was analyzed statistically in FCRD (Factorial Completely Randomized Design) by Gomez and Gomez (1984). Treatment combinations are given in Table 1.

**Table 1. Treatment combinations**

| S No. | Treatment combinations |
|---|---|
| 1. | $T_1$ – Control (Water spray) |
| 2. | $T_2$ – Nutrio-hormonal consortia 1 |
| 3. | $T_3$ – Nutrio-hormonal consortia 2 ($T_2 + K_2SO_4$) |
| 4. | $T_4$ – Groundnut Booster 1 ($FeSO_4$, $K_2SO_4$, $MgSO_4$, Borax) |
| 5. | $T_5$ – Groundnut Booster 2 ($T_4$ + Salicylic acid + Naphthalene acetic acid) |

## 3. RESULTS AND DISCUSSION

### 3.1 Normalized Difference Vegetation Index (NDVI)

The values for both crop varieties were between 0.81 and 0.88. In VRI 8 there was a significant increase in NDVI values from control (0.82) to $T_5$ (0.88). There was the slight decrease in NDVI values at 75 days after sowing compared to 50 days. The values were similar for both crop types. This means that there wasn't a significant difference in the treatments or the crop varieties. Values of normalized difference vegetation index, which are indicators of N content in the crop canopy and crop vigor, were considerably higher when treated with N-containing fertilizers [5].

### 3.2 Leaf Area

There is a significant difference between $T_1$ and $T_5$. In VRI 8, a higher leaf area was recorded in $T_4$ (2297.14 $cm^2$) which is on par with $T_5$ (2245.2$cm^2$). Foliar application of nutrients with PGRs ($T_5$) increased the leaf area up to 19% compared to control. Leaf area in groundnut refers to the total surface area of the leaves on a plant. It's an important measure because it indicates the overall photosynthetic capacity of the plant, which directly affects its growth, development, and yield. The percentage of leaf area on a groundnut plant indicates photosynthetic activity by regulating the amount of sunlight absorbed. At the flowering and pod-formation stages, foliar sprays of zinc and boron increased leaf area by 55% and 29%, respectively. Salicylic acid and naphthalene acetic acid are plant growth regulators that can influence various aspects of plant development. When applied to plants, they can stimulate cell elongation, leading to increased leaf size and, consequently, an increase in leaf area [6].

### 3.3 Specific Leaf Weight (SLW)

Compared to VRI 8, the foliar application of $T_5$ on BSR 2 resulted in a higher specific leaf weight (63.87mg $cm^{-2}$). This also indicates that more photo assimilates were retained in the leaf and only a small amount was translocated to the sink. As a result, it is concluded that VRI 8 is the superior genotype for photo assimilate translocation from source to sink. There is a significant difference between all treatments in both varieties. SLW is a valuable parameter for assessing the physiological state and health of plants, as it provides insights into the thickness and density of leaves, which are directly related to their capacity for photosynthesis and overall metabolic activity.

### 3.4 Total Dry Matter Production (TDMP)

The dry biomass of groundnut varied significantly among all the treatments in Table 5. Foliar spray of potassium, sulphur, boron and NAA resulted in higher biomass yield (251 g plant$^{-1}$) in $T_5$ when compared to all other treatments. In soybean, foliar application of B and Mo @ 0.5% concentration also improved the dry matter production and leaf area index [5]. Application of N @ 50 kg/ha + S @ 40 kg/ha in groundnut resulted in the highest dry matter production [7]. Application of gypsum @ 400 kg/ha + boron @10 kg/ha enhanced dry weight in groundnut [8].

### 3.5 Pods per Plant

The Highest number of pods/plant (37) were significantly recorded in BSR 2 with foliar application of $T_5$ in Fig. 1. The application of iron had a positive impact on crop growth and yield attributes, which in turn affected seed and haulm yield with a corresponding increase in the B: C ratio. With two foliar applications of ferrous sulphate @0.5% + 0.1% citric acid at 45 and 60 days after sowing along with a recommended dose of fertilizers, the maximum number of pods/plant, no. of kernels/pod and yield were recorded [9]. A Foliar spray of boron in groundnut during the pod formation stage resulted in a greater number of pods [5].

### 3.6 Pod Yield

Genotype VRI 8 recorded significantly higher pod yield (8.16 g/plant) in $T_5$ shown in Fig. 2. Foliar application of nutrients with PGRs ($T_5$) increased the pod yield up to 13% compared to the control.

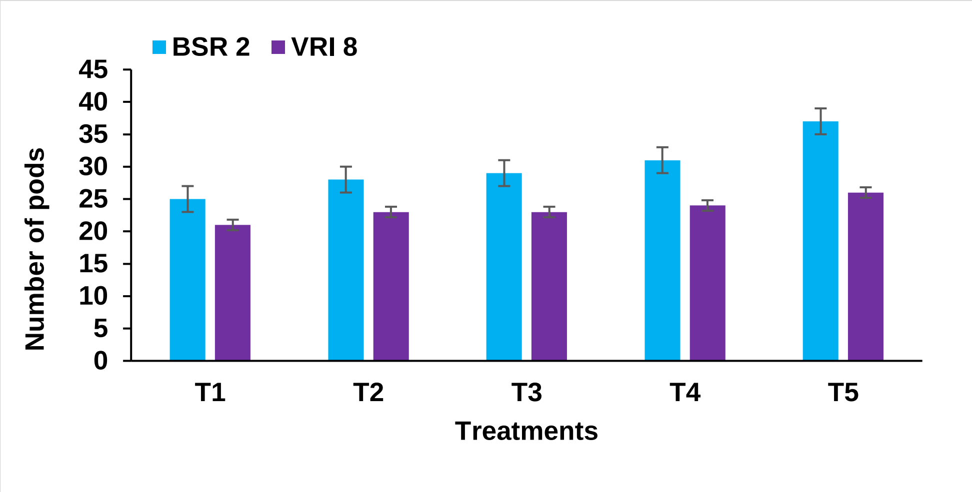


**Fig. 1. Effect of foliar application of nutrio-hormonal consortia on number of pods per plant in groundnut**

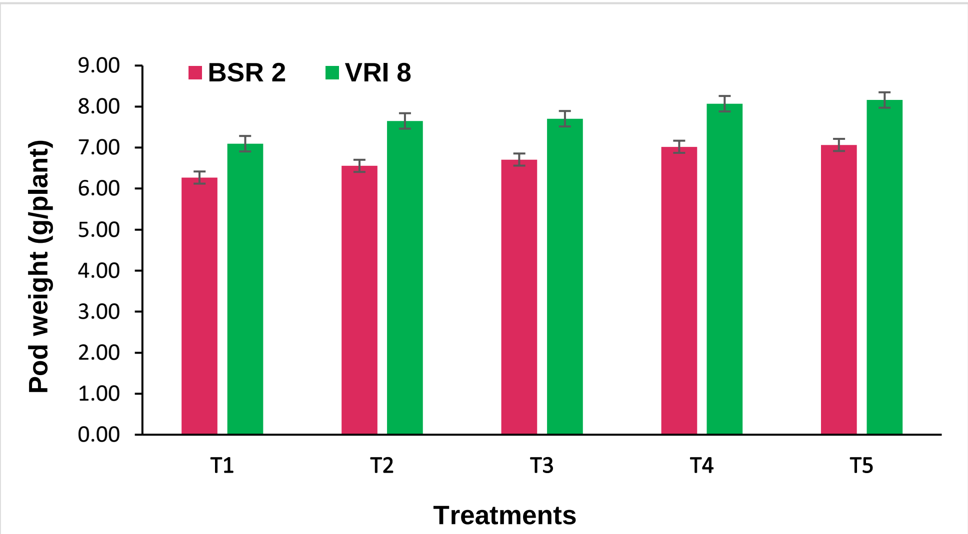


**Fig. 2. Effect of foliar application of nutrio-hormonal consortia on pod yield (g plant$^{-1}$) in groundnut**

**Table 2. Effect of foliar application of nutrio-hormonal consortia on NDVI values in groundnut**

| Treatment/variety | 50 DAS* | | | 75 DAS | | |
|---|---|---|---|---|---|---|
| | **BSR 2** | **VRI 8** | **MEAN** | **BSR 2** | **VRI 8** | **MEAN** |
| $T_1$ – Control (Water spray) | 0.81 | 0.82 | **0.82** | 0.80 | 0.81 | **0.81** |
| $T_2$ – Nutrio-hormonal consortia 1 | 0.83 | 0.85 | **0.84** | 0.82 | 0.83 | **0.83** |
| $T_3$ – Nutrio-hormonal consortia 2 ($T_2 + K_2SO_4$) | 0.86 | 0.86 | **0.86** | 0.84 | 0.84 | **0.84** |
| $T_4$ – Groundnut Booster 1 ($FeSO_4$, $K_2SO_4$, $MgSO_4$, Borax) | 0.87 | 0.87 | **0.87** | 0.84 | 0.85 | **0.85** |
| $T_5$ – Groundnut Booster 2 ($T_4$ + Salicylic acid + Naphthalene acetic acid) | 0.88 | 0.88 | **0.88** | 0.86 | 0.86 | **0.86** |
| **MEAN** | **0.85** | **0.86** | **0.85** | **0.83** | **0.84** | **0.84** |
| **SEd** | **T*** | **V*** | **TxV*** | **T** | **V** | **TxV** |
| | **0.33** | **0.021** | **0.047** | **0.32** | **0.02** | **0.045** |
| **CD (P=0.05)** | **0.68** | **0.043** | **0.098** | **0.66** | **0.041** | **0.093** |

**DAS: Days after sowing *T: Treatment *V: Variety *TxV: Interaction effect*

**Table 3. Effect of foliar application of nutrio-hormonal consortia on leaf area ($cm^2$) in groundnut**

| Treatment/variety | 50 DAS* | | | 75 DAS | | |
|---|---|---|---|---|---|---|
| | **BSR 2** | **VRI 8** | **MEAN** | **BSR 2** | **VRI 8** | **MEAN** |
| $T_1$ – Control (Water spray) | 593.14 | 1779.14 | **1186.14[c]** | 630.85 | 1862.22 | **1246.53[b]** |
| $T_2$ – Nutrio-hormonal consortia 1 | 694.32 | 1871.30 | **1282.81[bc]** | 709.89 | 1929.24 | **1319.56[b]** |
| $T_3$ – Nutrio-hormonal consortia 2 ($T_2 + K_2SO_4$) | 739.10 | 1884.25 | **1311.68[b]** | 745.63 | 1938.17 | **1341.90[b]** |
| $T_4$ – Groundnut Booster 1 ($FeSO_4$, $K_2SO_4$, $MgSO_4$, Borax) | 904.61 | 2297.14 | **1600.88[a]** | 948.61 | 2387.44 | **1668.03[a]** |
| $T_5$ – Groundnut Booster 2 ($T_4$ + Salicylic acid + Naphthalene acetic acid) | 829.81 | 2245.22 | **1537.52[a]** | 862.09 | 2297.83 | **1579.97[a]** |
| **MEAN** | **752.20** | **2015.41** | **1383.80** | **779.42** | **2082.98** | **1431.20** |
| **SEd** | **T*** | **V*** | **TxV*** | **T** | **V** | **TxV** |
| | **59.65** | **37.73** | **84.37** | **61.789** | **39.08** | **87.38** |
| **CD (P=0.05)** | **124.44** | **78.70** | **175.9** | **128.88** | **81.52** | **182.27** |

**Table 4. Effect of foliar application of nutrio-hormonal consortia on specific leaf weight (mg cm$^{-2}$) in groundnut**

| Treatment/variety | 50 DAS* | | | 75 DAS | | |
|---|---|---|---|---|---|---|
| | **BSR 2** | **VRI 8** | **MEAN** | **BSR 2** | **VRI 8** | **MEAN** |
| $T_1$ – Control (Water spray) | 35.40 | 19.11 | **27.26$^c$** | 28.53 | 16.65 | **22.59$^d$** |
| $T_2$ – Nutrio-hormonal consortia 1 | 43.21 | 20.84 | **32.02$^b$** | 39.44 | 18.66 | **29.05$^c$** |
| $T_3$ – Nutrio-hormonal consortia 2 ($T_2$ + $K_2SO_4$) | 46.00 | 21.76 | **33.88$^b$** | 44.26 | 19.61 | **31.93$^b$** |
| $T_4$ – Groundnut Booster 1 ($FeSO_4$, $K_2SO_4$, $MgSO_4$, Borax) | 46.43 | 20.90 | **33.66$^b$** | 40.06 | 19.69 | **29.87$^{bc}$** |
| $T_5$ – Groundnut Booster 2 ($T_4$ + Salicylic acid + Naphthalene acetic acid) | 63.87 | 23.16 | **43.52$^a$** | 54.52 | 21.32 | **37.92$^a$** |
| **MEAN** | **46.98** | **21.15** | **34.07** | **41.36** | **19.18** | **30.27** |
| **SEd** | **T*** | **V*** | **TxV*** | **T** | **V** | **TxV** |
| | **1.38** | **0.88** | **1.96** | **1.23** | **0.78** | **1.73** |
| **CD (P=0.05)** | **2.89** | **1.83** | **4.08** | **2.56** | **1.62** | **3.67** |

**DAS: Days after sowing *T: Treatment *V: Variety *TxV: Interaction effect*

**Table 5. Effect of foliar application of nutrio-hormonal consortia on total dry matter production (g plant$^{-1}$) in groundnut**

| Treatment/variety | 50 DAS* | | | 75 DAS | | |
|---|---|---|---|---|---|---|
| | **BSR 2** | **VRI 8** | **MEAN** | **BSR 2** | **VRI 8** | **MEAN** |
| $T_1$ – Control (Water spray) | 101.0 | 121.0 | **111.0$^e$** | 116.0 | 162.0 | **139.0$^d$** |
| $T_2$ – Nutrio-hormonal consortia 1 | 106.0 | 148.0 | **127.0$^d$** | 128.0 | 173.0 | **150.5$^d$** |
| $T_3$ – Nutrio-hormonal consortia 2 ($T_2$ + $K_2SO_4$) | 147.0 | 162.0 | **154.5$^c$** | 191.0 | 185.0 | **188.0$^c$** |
| $T_4$ – Groundnut Booster 1 ($FeSO_4$, $K_2SO_4$, $MgSO_4$, Borax) | 182.0 | 186.0 | **184.0$^b$** | 208.0 | 206.0 | **207.0$^b$** |
| $T_5$ – Groundnut Booster 2 ($T_4$ + Salicylic acid + Naphthalene acetic acid) | 194.0 | 206.6 | **200.3$^a$** | 231.0 | 251.0 | **241.0$^a$** |
| **MEAN** | **146.0** | **164.7** | **155.4** | **174.8** | **195.4** | **185.1** |
| **SEd** | **T*** | **V*** | **TxV*** | **T** | **V** | **TxV** |
| | **6.17** | **3.90** | **8.73** | **7.24** | **4.58** | **10.24** |
| **CD (P=0.05)** | **12.87** | **8.14** | **18.20** | **15.11** | **9.56** | **21.37** |

**DAS: Days after sowing *T: Treatment *V: Variety *TxV: Interaction effect*

Foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM/ha significantly increased pod yield, haulm yield, biological yield, pod/plant, shelling percentage, and seed index of groundnut [10]. The progressive effect of potassium and magnesium on yields could be attributed to potassium's important role in carbohydrate synthesis, photosynthesis, and cell elongation. These results were also found similar with Sandeep et al. [4].

## 4. CONCLUSION

Foliar application of $T_5$ – Groundnut Booster 2 ($T_4$ + Salicylic acid + Naphthalene acetic acid) on VRI 8 recorded higher pod yield compared to all other treatments. The results proved that foliar application of nutrients with plant growth regulators improves growth and yield Thus, to realize potential yields and profits groundnut crop needs foliar application of nutrients with plant growth regulators.


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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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