**IMPACT OF TNAU PULSE WONDER ON PHYSIOLOGICAL AND YIELD PARAMETERS IN BLACKGRAM** (*Vigna mungo*)

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**ABSTRACT**

Investigations were undertaken to study the effect of pulse wonder on growth and productivity of black gram variety CO 6. Morphological and growth characters were measured at seven days after the foliar application of MAP and Pulse wonder and physiological and biochemical parameters were estimated at seven days after the foliar application of MAP and Pulse wonder of green gram. The number of pods per plant and yield per plant were assessed at the time of harvest of green gram. The foliar application of pulse wonder @ 2 kg per acre favourably influenced the shoot length and root length. The number of leaves was increased due to foliar application of pulse wonder @ 2 kg per acre. Increase in the total dry matter production was recorded by the foliar spray of pulse wonder @ 2 kg per acre in black gram. There was also increase in the Leaf Area Index (LAI) and chlorophyll Stability Index of the leaf due to foliar spray of pulse wonder @ 2 kg per acre in black gram. The biochemical constituents such as soluble protein content and the activity of nitrate reductase were also greatly enhanced by the foliar spray of pulse wonder @ 2 kg per acre treatment in black gram. The number of pods per plant was significantly increased by the foliar application of pulse wonder @ 2 kg per acre in black gram. The overall results as evidenced by the yield per plant in black gram revealed that foliar spray of pulse wonder @ 2 kg per acre is advantageous and can be recommended for foliar application by the farmers to increase the black gram production and productivity.

***Key Words:*** TNAU Pulse Wonder, Foliar spray, Physiology, Yield, Blackgram.

**INTRODUCTION**

Blackgram (*Vigna mungo*,) is a short duration legume crop primarily grown for its dry seeds. It is an excellent source of protein (24 %) with high digestibility. The slow rate of dry matter accumulation during pre-flowering phase, poor pod setting, earlier onset of leaf senescence during the period of pod development and low partitioning efficiency of assimilates to the grains were identified as the main physiological constraints for the yield. The Nutrients and Plant Growth Regulators (PGR) play a major role in the alteration of source and sink relationship in pulses. Urea is one of the nitrogenous fertilizers which is having 46 % primary nutrient, nitrogen (N). It is an essential component of proteins, protoplasm and chlorophyll. In addition, N is a constituent of purine, pyrimidine, porpyrins and coenzymes. The propyrin structure contains N which is found in some metabolically important compounds such as the chlorophyll pigments and the cytochromes essential for photosynthesis and respiration respectively. Application of N significantly increased the plant height, number of leaves, Leaf Area Index (LAI), dry matter accumulation and yield (Parihar *et al.,* 1998). Spray of N significantly increased the number of pods and seed yield of green gram (Yakadri *et al.,* 2002). Plants absorb iron from the soil in both Fe2+ and Fe3+ forms. Iron is a constituent of cytochromes, ferredoxin, catalase, peroxidase, ferrichrome etc. In cells, most of the iron is present in the chloroplasts. It is required in chlorophyll synthesis. Zinc is involved in biosynthesis of plant auxin. It acts as an activator of carbonic anhydrase (CO2 fixing enzyme), alcohol dehydrogenase and lactic dehydrogenase. Zinc plays an important role in protein synthesis, as amino acids and amides in zinc deficient plants. It is required for chlorophyll synthesis. Balakrishnan (2001) found that foliar application of Fe significantly increased the shoot growth, yield and quality of guava fruits. Boron is absorbed from soils as undissociated form of boric acid (H3BO3). Though the symptoms of boron are very striking, its role in plant metabolism is uncertain. The boron has been found to be involved in the carbohydrate transport system within the plant. Balakrishnan (2001) found that foliar application of Fe significantly increased the shoot growth, yield and quality of guava fruits. Narashimha *et al.* (2005) reported that spraying of 1 % borax concentration increased the harvest index in chick pea. Molybdenum ion is the part of the nitrogen fixing enzymes such as nitrate reductase (NRase) and nitrogenase. The NRase catalyses the reduction of nitrate to nitrite during its assimilation by the plant cell, while the nitrogenase enzyme converts nitrogen gas to ammonia in nitrogen-fixing micro organisms. Molybdenum also plays a role in the break down of purines such as adenine and guanine because of its essentiality as part of the enzyme xanthin dehydrogenase. Gupta (1994) reported that molybdenum increased the protein content of soybean. Singh *et al.* (2002) reported that application of molybdenum substantially increased the seed yield of soybean. Leaf is considered as an important functional unit of plant which contributes to the yield. Positive correlation between yield and number of leaves was observed in mungbean by Chandrababu (1990). The percentage decrease in the number of leaves from pod filling to maturity was found to be least in NAA spray in green gram (Sujatha, 2001). The number of leaves per plant was increased by the application of NAA in cowpea (Shinde and Jadhav, 1995). Pipattanawong *et al.* (1996) reported that foliar application of 0.1 ppm brassinolide increased the number of leaves per plant in strawberries. In wheat, seed treatment with brassinolide (3 µM for 8 or 12 hours) showed higher leaf number (Hayat *et al.,* 2001). The application of NAA 40 ppm increased the DMA in pigeonpea (Shinde and Jadhav, 1994). Brassinolide application (5μM) increased the dry matter accumulation in the treated internode of bean plant (Krizek and Mandava, 1983). Kinetin and ethrel applications increased the dry matter accumulation in the peak grain growth period (Sekhon and Singh, 1994).

The NRase is the rate limiting enzyme in nitrogen assimilation and is a key point of metabolic regulation (Eilrich and Hageman, 1973) in crops. Sairam (1994) found that application of brassinosteroid increased the nitrate reductase activity in wheat crop. Lakshmamma and Subba Rao (1996) reported that NAA application at 50 per cent flowering increased the NRase activity in black gram. Soluble protein serves as an indicator of photosynthetic efficiency in terms of the RUBP carboxylase activity (Evans, 1975). Diethelm and Shibles (1989) had opined that the Rubisco content per unit leaf area was positively correlated with that of the soluble protein content. Foliar application of brassinolide and 24-epibrassinolide at 0.5 μM to 3.0 μM concentrations increased soluble protein contents in groundnut (Vidyavardhini and Seeta Rama Rao, 1997). Foliar spraying of NAA significantly increased the leaf soluble protein content of soybean as reported by Rajamohan (1989) and Kalarani (1991). Kalita (1989) found a significant increase in the number of pods in green gram by foliar application of NAA. Zhao Huijie *et al.* (1995) opined that SA increased the number of pods per plant in soybean. Foliar spray of 25 ppm NAA recorded significantly higher seed yield by 21 - 22 per cent than control through increased pods per plant in mungbean (Patil *et al.,* 2005). Foliar application of 50 ppm NAA at pre-flowering stage recorded the seed yield of 670 kg / ha when compared with   
control (550 kg/ha) in mungbean (Kandagal *et al.,* 1990). There was a significant yield increase in mungbean when treated with ascorbic acid, SA and ethrel (Pawan *et al.,* 1989). Foliar spray of 10-5 M-benzyl amino purine increased crop yield of triticale (Stankova *et al.,* 1990). Ethrel application increased the maize yield by increasing kernel number and ear length under water stress (Renu Dogra and Thukral, 1989). Foliar spraying of 20 ppm benzyl adenine increased the yield of rice (Anandhakrishnaveni *et al.,* 2001).

# MATERIALS AND METHODS

The present investigation was undertaken under field condition to study the impact of TNAU Pulse Wonder on physiological and yield parameters in blackgram. The details of the materials used and methodologies followed in this experiment are presented below. TNAU pulse wonder, Mono Ammonium Phosphate (MAP) were used.

**MATERIALS**

The experiment was laid out under field conditions. The blackgram CO 6 variety were chosen for this experiment. The duration of the variety is 75 days with the yield of 877 kg ha-1. The plot size is 4 x 3 m with the spacing of 30 x 10 cm were maintained. The data were analyzed by using Randomized Block Design with seven replications. Three treatments were imposed viz., T1 - Control , T2 – Pulse Wonder (5 kg ha-1), T3 – MAP 1%.

**Observations recorded**

The morphological characters, growth attributes, physiological components and biochemical constituents were recorded during vegetative, flowering and maturity stages of the crop. The yield components and seed yield were assessed at the time of harvesting.

**Morphological parameters**

The morphological parameters were recorded seven days after the application of treatment by selecting five representative plant samples at random from each replication. The methods adopted for each of these parameters are described below.

**Shoot length**

## The height of the shoot was measured from the base of the shoot to the longest leaf tip and the mean value was worked out and expressed as cm.

**Root length**

For the measurement of root length, the plants were uprooted care­fully from the soil with minimum damage and the mean length from the base of the root to the tip of the longest root was measured and expressed as cm.

**Number of leaves**

Number of leaves was counted in the five plants selected at random from each plot in each replication and the mean value was worked out and expressed in number.

**Growth attributes**

**Leaf area index**

The LAI was calculated by employing the formula of Williams (1946).

##### Leaf area per plant (cm2)

##### LAI = -----------------------------------------------

Ground area occupied by the plant (cm2)

**Total dry matter production**

Plant samples were first shade dried and then oven dried at 70 °C for 48 hours.   
The dry weight of whole plant including the seeds was taken and expressed as g plant-1.

**Biochemical parameters**

**Chlorophyll Stability Index (CSI)**

The Chlorophyll stability index (CSI) was determined by adopting the method of Leopold *et al,* (1981) and expressed in percentage.

Total chlorophyll content (treated)

CSI = ­­ x 100

Total chlorophyll content (control)

**Soluble protein content**

The content of soluble protein was estimated from the leaf samples following the method of Lowry *et al*. (1951) and expressed as mg g-1 fresh weight.

**Nitrate reductase activity**

Nitrate reductase activity in the leaves was determined by adopting the method of Nicholas *et al.* (1976) and the enzyme activity was expressed as µg of NO-2 g-1 hr-1.

**Yield and yield components**

The important components contributing to the yield potential of the crop were recorded from the commencement of flowering to the harvest of the crop. Different yield parameters recorded in the present study are indicated below.

**Number of pods per plant**

The number of pods produced in each plant was counted from the five plant samples in each treatment and replication at the harvest stage and the average was calculated and expressed in number.

**Grain yield per hectare**

Based on the population, the grain yield per hectare was calculated and expressed in kg ha-1.

**RESULTS**

A field experiment was carried out at Tamil Nadu Agricultural University, Coimbatore during 2017 to evaluate the effect of TNAU pulse wonder and Mono Ammonium Phosphate (MAP) on physiological and yield parameters of black gram variety CO6. All the characters were recorded at seven days after the foliar application of TNAU pulse wonder and MAP. The influence of TNAU pulse wonder and MAP applied was studied in terms of morphological, physiological, biochemical, yield components and yield. The data are presented in appropriate tables in this chapter. The details of the experimental results are presented below.

**Morphological characters**

**Shoot length (cm)**

The result on shoot length was increase in trend were noticed in T2 (Pulse Wonder) with the value of 24.81cm followed by T3 (MAP) 22.65 cm. The lowest length of shoot was registered in the control (T1). Hence the foliar application of Pulse Wonder showed 66.84% increase in shoot length over control.

**Root length (cm)**

The data on root length was increase in trend were noticed in T2 (Pulse Wonder) with the value of 15.88 cm, followed by T3 (MAP) 15.58 cm. The lowest root length was observed in T1 (Control) which is 15.17 cm. So, the foliar application of Pulse Wonder increased the root length 4.68% more over control.

**Number of leaves**

The result on number of leaves was increase in trend were observed in T2 (Pulse Wonder) with the value of 52 which was 40.54% more over the control, followed by T3 (MAP) with the value of 40. Hence, the foliar application of Pulse Wonder affected the number of leaves in the plant over the control.

**Growth attributes**

**Leaf Area Index (LAI)**

It is observed that leaf area index was increase in trend were noticed in T2 (Pulse Wonder) in the value of 27.64 cm­2, which was followed by T3 (MAP) i.e., 20.68 cm2. The lowest leaf area index was noticed in T1 (Control) which is 19.40 cm2. Hence, the foliar application of Pulse Wonder increased the leaf area by 42.47% over the control (T1).

**Total Dry Matter Production:**

The data on dry matter production was increase in trend were observed in T2 (Pulse Wonder) in the value of 7.00 g plant-1, which was followed by T3 (MAP 1%) (6.12 g plant-1). The lowest value of dry matter production was recorded in T1 (Control) which is 5.63g plant-1 Hence the dry matter production was increased to 24.33% by foliar application of Pulse Wonder over control.

**Physiological and Biochemical parameters**

**Chlorophyll Stability Index (CSI)**

The result on chlorophyll stability index was increase in trend were observed in T2 (Pulse Wonder) in the value of 83.60%, which was followed by T3 (MAP) which is 76.30%. The lowest value of CSI was recorded in T1 (Control) which is 70.0%. Hence the foliar application of Pulse Wonder increased the chlorophyll stability index by 19.42% over control.

**Nitrate reductase activity(µg of NO2 g-1 hr-1)**

The result on Nitrate Reductase Activity was increase in trend were noticed in T2 (Pulse Wonder) in the value of 333.0 µg of NO2 g-1 hr-1, which was followed by T3 (MAP) which is 267.0 µg of NO2 g-1 hr-1. The lowest value of Nitrate Reductase Activity was recorded in T1 (Control) which is 200 µg of NO2 g-1 hr-1. Hence the foliar application of Pulse Wonder increased the Nitrate Reductase Activity by 66.5 %over control.

**Soluble protein**

The dataon soluble protein was increase in trend were observed in T2 (Pulse Wonder) in the value of 19.40%, which was followed by T3 (MAP) which is 18.0%. The lowest value of soluble protein was recorded in T1 (Control) which is 15.70%. Hence the foliar application of Pulse Wonder increased the soluble protein by 23.56% over control.

**Yield and yield components**

**Number of pods per plant**

The result on pods per plant was increase in trend were observed in T2 (Pulse Wonder) in the value of 16 pods per plant which was followed by T3 (MAP) which is 14 pods per plant. The lowest value was recorded in T1 (Control) which is 13 pods per plant. Hence the foliar application of Pulse Wonder increased the No. Of Pods per plant by23.07 % over control.

**Yield (g plant-1)**

The data on yield was increase in trend were observed in T2 (Pulse Wonder) in the value of 4.72 g per plantwhich was followed by T3 (MAP) which is 4.23 g per plant. The lowest value of yield was recorded in T1 (Control) which is 2.41 g per plant. Hence the foliar application of Pulse Wonder increased the yield by 95.85% over control.

**DISCUSSION**

Productivity of pulses in India is low when compared to world average. The sluggish growth in pulses in the country could be due to various agronomical, physiological, biochemical as well as inherent factors associated with the crop. The major physiological constrains limiting the productivity of the crop are shedding of flowers and fruits and very low fruit set per cent, because of limitations in source strength at the rime of flowering and fruiting of the crop. To overcome these problems and to enhance the productivity of black gram, through foliar application of TNAU pulse wonder and Mono Ammonium Phosphate (MAP), the present investigation was undertaken at field level employing the black gram variety CO 6.

**Effect of TNAU pulse wonder and MAP on Morphological characters in blackgram**

The influence of nutrients and plant growth regulators on the growth of black gram exhibited significant variations at all the phenological stages. The growth in terms of **shoot length** consistently increased with the foliar application of pulse wonder. This finding of the present study is in line with the results of Marimuthu and Surendran (2015) in black gram in which increase in growth characters might be due to combination of nutrient and growth regulator as foliar spray plays a major role in growth development and metabolism of black gram. Marimuthu and Surendran (2015), who reported that basal and foliar application of 100% recommended dose of NPK+DAP2%+TNAU pulse wonder 5 kg per hectare had higher shoot length in terms of plant height in blackgram. In the present study also, the accelerated shoot growth in terms of height was considerably increased by the foliar application of TNAU pulse wonder.

The **root length** is an important morphological parameter involved in improving water and nutritional status of the plant. The foliar application of nutrients and growth regulating chemicals viz., MAP and TNAU pulse wonder and high dose of nitroen were equally effecting in enhancing the root growth of black gram as observed in the present study. In the present study, the foliar spray of TNAU pulse wonder caused a remarkable enhancement in root length. This finding was strongly supported by the results of Marimuthu and Surendran (2015), who reported that application of 100% recommended dose of NPK + DAP2% + TNAU pulse wonder 5 kg ha-1 had highest growth characters in black gram.

Leaf is considered as an important functional unit of the plant, since it harnesses light energy and converts into assimilatory compounds. **Leaf number** is always positively correlated with final yield of the crop (Chandrababu, 1990). The present study demonstrated the favourable effects of nutrients and growth hormones on leaf production.

The foliar application of TNAU pulse wonder and MAP 1% caused higher leaf production over control. This finding was corroborated with the results of Umadevi (1998) in sesame, in which combined application of nutrients and growth regulating chemicals caused a significant increase in leaf number. Besides accelerating the leaf production, the delayed abscission of leaves might be the possible reason for the maintenance of higher number of leaves in strawberry as explained by Leece and Ken Worthy (1971).

**Influence of TNAU pulse wonder and MAP on growth attributes.**

**Leaf area** is a fundamental determinant of the total photosynthesis of a plant. Leaf area always shows a positive relationship with net photosynthetic activity, because leaf enlargement is attributed to increase in number and width of grana and also high degree of stacking of grana (Fortun *et al.*, 1985). Therefore, leaf area with high photosynthetic activity has a direct relationship with seed yield of the crop plants (Thandapani, 1985 and Chandrababu, 1990). The result of the present study indicates the influence of TNAU pulse wonder 5 kg per hectare and mono ammonium phosphate (MAP 1%) on leaf area improvement. Foliar spray of TNAU pulse wonder 5 kg per hectare exhibited a profound effect on leaf enlargement over control. Goswami and Srivastava (1987) further explained that Urea application combination with plant growth regulating substances arrested the chlorophyll degradation and protease activity and promoted the synthesis of photosynthetic enzymes and soluble protein content, resulting in more assimilatory surface area for longer period.

**Leaf area index** is one of the principle factors influencing canopy net photosynthesis of the crop plants (Hansen, 1972). Patra *et al*. (1995) stated that total dry matter production and pod yield of groundnut were attributed to higher LAI through facilitating efficient interception of light. As observed from the results of leaf area, leaf area index was also greatly influenced by TNAU pulse wonder 5 kg per hectare treatments.

**Effect of TNAU pulse wonder and MAP on total dry matter production**

Total dry matter production and its partitioning is the integral part of the growth over the entire growing period and is related to seed yield. The indeterminate growth habit of pulses that sets in competition for photoassimilates among simultaneously growing leaf, stem and reproductive parts leads to insufficient availability of assimilates. This constraint can be overcome by applying synthetic plant growth regulators to improve canopy structure, synchronous flowering and fruit set. In the present study an increase in dry matter accumulation was observed in the treatment of foliar application of TNAU pulse wonder 5 kg per hectare. Application of TNAU pulse wonder 5 kg per hectare recorded the highest TDMP with the increase of 24 per cent over control at the final stage of the crop. The foliar spray of nutrients with growth promoting hormones influenced the total dry matter production in black gram through retarding the leaf senescence and facilitating the longer retention of the effective photo assimilatory surfaces (Prabakaran, 2002).

**Effect of TNAU pulse wonder and MAP on physiological and biochemical components.**

The increase in chlorophyll content reflects increased PS II photochemistry, photosynthates production and dry matter accumulation. The result of the present study indicated that the fractions of chlorophyll, a and b also total chlorophyll increased up to pod filling stage and declined at the time of harvest. Chlorophyll accumulation in leaves was double time higher between flowering and pod filling stages, as compared to vegetative stage, whereas, for chlorophyll b, the maximum accumulation was noticed at vegetative stage itself. The total chlorophyll content, however, reflected the trend of chlorophyll a content. At the time of harvest, chlorophyll a and total content showed about 30 per cent reduction, whereas chlorophyll b showed only 10 per cent reduction. This decline was related to the activation of chlorophyllase enzyme, as the result, the water soluble porphyrin fragments were exported from chloroplast to vacuole, thus there was a loss in leaf greenness (Matile *et al*., 1982). The nutrients and plant growth regulators played a productive role in upregulating the enzymes involved in chlorophyll synthesis. The treatmental combination N (25 kg ha-1) + BR (0.1 ppm) + Urea (2%) caused a remarkable increase in a, b and total content of the leaves at all the stages of the growth, as observed in the present study. This finding was strongly supported by the results of Prabakaran (2002) in black gram. Mitra and Ghildyal (1987) opined that the supply of nitrogen through foliage is essential during pod developmental stage for the maintenance of high rate current photosynthesis. Kulaeva *et al*., (1991), however, specified the role of BR in inducing chlorophyll synthesis, through the activation of enzyme proteins. In mung bean, the enhancement in chlorophyll content by BR treatment had been attributed to several factors including inhibition of senescence and enhanced uptake of iron (Bhatia and Jatinder kaur, 1997). Similarly in wheat high photosynthetic rate induced by BR application was directly related to enhanced chlorophyll content of the leaf (Sairam, 1994). In addition to the combination with BR 0.1 ppm, CCC 200 ppm along with Urea 2 per cent also revealed its significant effect in enhancing the chlorophyll content of the present study. Ameregouda *et al*. (1994) supported this finding with the result that in wheat, foliar spray of CCC was found highly effective in increasing the chlorophyll content of the leaf. Similar finding made by Sumathi (2005) in pigeon pea was also in close confirmity with the results of the present study.

The **soluble protein content** of the leaf, being a measure of RuBP carboxylase activity was considered as an index for photosynthetic efficiency. These were reports that RuBP-case enzyme forms nearly 50 per cent of the soluble proteins in leaves of many plants (Joseph *et al.,* 1981). Diethelm and Shibles (1989) opined that the RUBISCO content per unit leaf area was positively correlated with that of souble protein content of the leaf. This finding strongly supported the results of the present study, which indicated that the treatment of foliar application of TNAU pulse wonder 5 kg per hectare enhanced the soluble protein content by more than 26 per cent over control. This effect of TNAU pulse wonder increased level of soluble protein content in the treated plants might be due to induction of specific metabolic changes and increased protein synthesis in cells.

The **nitrate reductase** is the rate-limiting enzyme in nitrogen assimilation and is a key point of metabolic regulation (Eilrich and Hageman, 1973) in crop plants. Thus, NRase is intimately associated with the plant growth and development (Sinha and Nicholas, 1981). However in the present study high NRase activity was recorded after the foliar application of TNAU pulse wonder 5kg per hectare, which might be due to the nutrients and plant growth regulating chemicals present in the TNAU pulse wonder applied through foliage.

**Effect of TNAU pulse wonder and MAP on seed yield of black gram**

The foliar application of TNAU pulse wonder @ 5kg per hectare and MAP 1% showed significant influence on **grain yield** of black gram. The production of higher seed yield due to growth regulators may be attributed to the fact that plants treated with growth regulators remained physiologically more active to build up sufficient food reserves for developing flowers and seeds. Thus the plants showed improved flower production with high fruit set and better seed development. The result of the present study indicated that the treatment of foliar application of TNAU pulse wonder @ 5kg per hectare was found to be the most effective treatment in improving the grain yield by 35 to 40 per cent over control. The findings of Mallika Vanangamudi *et al*. (2004) explained the significant effect of nutrients combination with plant growth regulating chemicals in improving the yield of black gram and green gram. The yield improvement was attributed to more number of branches bearing fruits due to availability of higher amount of nutrients and hormones to the crop.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Shoot length (cm)** | | | | **Root length (cm)** | | | |
| **R1** | **R2** | **R3** | **Mean** | **R1** | **R2** | **R3** | **Mean** |
| **T1** | 14.23 | 15.01 | 15.36 | **14.87** | 14.53 | 15.31 | 15.66 | **15.17** |
| **T2** | 24.17 | 24.95 | 25.30 | **24.81** | 15.24 | 16.02 | 16.37 | **15.88** |
| **T3** | 22.01 | 22.79 | 23.14 | **22.65** | 14.94 | 15.72 | 16.07 | **15.58** |
| **Mean** | **20.14** | **20.92** | **21.27** |  | **14.90** | **15.68** | **16.03** |  |
| **(T – Treatment)**  **T1 – Control T2 – Pulse Wonder T3 -**  **MAP 1%** | | | | | | | | |

**Table 1. Effect of pulse wonder on shoot length (cm) and root length (cm) in black gram.**

**Table 2: Effect of pulse wonder on Number of leaves and Leaf Area in black gram.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Number of leaves** | | | | **Leaf Area (cm2 plant-1)** | | | |
| **R1** | **R2** | **R3** | **Mean** | **R1** | **R2** | **R3** | **Mean** |
| **T1** | 36.36 | 37.14 | 37.49 | **37.00** | 682.5 | 726.1 | 746.1 | **718.21** |
| **T2** | 51.36 | 52.14 | 52.49 | **52.00** | 1386.7 | 1448.4 | 1476.5 | **1437.24** |
| **T3** | 39.36 | 40.14 | 40.49 | **40.00** | 789.2 | 836.1 | 857.6 | **827.62** |
| **Mean** | **42.36** | **43.14** | **43.49** |  | **952.79** | **1003.55** | **1026.72** |  |
| **(T – Treatment)**  **T1 – Control T2 – Pulse Wonder T3 -**  **MAP 1%** | | | | | | | | |

**Table 3: Effect of pulse wonder on Dry Matter Production and Chlorophyll Stability Index in black gram.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Dry Matter Production (g plant-1)** | | | | **Chlorophyll Stability Index (%)** | | | |
| **R1** | **R2** | **R3** | **Mean** | **R1** | **R2** | **R3** | **Mean** |
| **T1** | 5.60 | 5.50 | 5.81 | **5.63** | 69.4 | 70.1 | 70.5 | **70.00** |
| **T2** | 6.97 | 6.87 | 7.18 | **7.00** | 83.0 | 83.7 | 84.1 | **83.60** |
| **T3** | 6.09 | 5.99 | 6.30 | **6.12** | 75.7 | 76.4 | 76.8 | **76.30** |
| **Mean** | **6.22** | **6.12** | **6.43** |  | **75.99** | **76.77** | **77.12** |  |
| **(T – Treatment)**  **T1 – Control T2 – Pulse Wonder T3 -**  **MAP 1%** | | | | | | | | |

**Table 4: Effect of pulse wonder on nitrate reductase activity and soluble protein in black gram.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Nitrate Reductase activity (ug of NO2 g-1hr-1)** | | | | **Soluble protein (mg g-1)** | | | |
| **R1** | **R2** | **R3** | **Mean** | **R1** | **R2** | **R3** | **Mean** |
| **T1** | 199.4 | 200.1 | 200.5 | **200.00** | 15.1 | 15.8 | 16.2 | **15.70** |
| **T2** | 332.4 | 333.1 | 333.5 | **333.00** | 18.8 | 19.5 | 19.9 | **19.40** |
| **T3** | 266.4 | 267.1 | 267.5 | **267.00** | 17.4 | 18.1 | 18.5 | **18.00** |
| **Mean** | **266.03** | **266.81** | **267.16** |  | **17.06** | **17.84** | **18.19** |  |
| **(T – Treatment)**  **T1 – Control T2 – Pulse Wonder T3 -**  **MAP 1%** | | | | | | | | |

**Table 5: Effect of pulse wonder on number of pods and yield in black gram.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Number of pods plant-1** | | | | **Yield (g plant-1)** | | | |
| **R1** | **R2** | **R3** | **Mean** | **R1** | **R2** | **R3** | **Mean** |
| **T1** | 12.4 | 13.1 | 13.5 | **13.00** | 2.7 | 2.6 | 2.9 | **2.73** |
| **T2** | 15.4 | 16.1 | 16.5 | **16.00** | 4.1 | 4.4 | 4.3 | **4.27** |
| **T3** | 13.4 | 14.1 | 14.5 | **14.00** | 3.6 | 3.8 | 3.9 | **3.77** |
| **Mean** | **13.69** | **14.47** | **14.82** |  | **3.47** | **3.60** | **3.70** |  |
| **(T – Treatment)**  **T1 – Control T2 – Pulse Wonder T3 -**  **MAP 1%** | | | | | | | | |

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