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## *Full Length Research Article*

# INFLUENCE OF FOLIAR APPLICATION OF NUTRIENTS ON BIOCHEMICAL PARAMETERS IN GREENGRAM (*VIGNA RADIATE* L. WILCZEK.)

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**ABSTRACT**

A field experiment was conducted during the *kharif* season of 2014 at Main Agriculture Research Station (MARS), University of Agriculture Sciences, Dharwad (Karnataka) to study the influence of foliar application of nutrients on morpho-physiological traits, yield and yield components in greengram. Nine treatments comprising of $KNO_3$ (0.1 %), $MnSO_4$ (0.3 %), $ZnSO_4$ (0.5 %), $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %), $KNO_3$ (1.0 %) + $ZnSO_4$ (0.5 %), $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %), $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %), Propiconazole (0.1 %) and Control (unsprayed) were laid out in randomized completely block design(RCBD) with three replications. Foliar application was done at two stages 35 and 50 days after sowing (DAS). Among these treatments, $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) recorded increased chlorophyll, phenol content and peroxidase activity. The seed yield parameters like number of pods per plant, number of seeds per pod, seed yield per plant, seed yield per hectare and also harvest index were found significantly maximum over the control by the foliar application of $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) and was on par with other treatments.



## INTRODUCTION

Greengram (*Vigna radiate* L. Wilczek) is an important short duration grain legume crop with wide adaptability, low input requirement and have the ability to improve soil fertility by fixing atmospheric nitrogen. The nutritive value of greengram lies in its high and easily digestible protein and contain approximately 25-28 per cent protein, 1.0 per cent oil, 3.5-4.5 per cent fiber, 4.5-5.5 per cent ash and 62-65 per cent carbohydrates on dry weight basis and methionine and lysine aminoacids comparatively large in greengram and its complement to rice in terms of balanced human nutrition. Greengram is grown mainly as a *kharif* season crop. However, its cultivation in *rabi* season is restricted to the eastern and southern parts of the country. The major greengram growing states are Orissa, Maharashtra, Andhra Pradesh, Rajasthan, Karnataka and Gujarat. Greengram crop is widely cultivated throughout South Asia including India, Pakisthan, Bangladesh, Sri Lanka, Thailand, Cambodia, Vietnum, Indonesia, Malaysia, and South Chaina. In India, it is the third most important pulse crop after chickpea and pigeonpea (Prasad., 2006). India alone accounts for 65 per cent of its world acreage and 54 per cent of the production. In India it occupies an area of 34.4 lakh ha with a total production of 14 lakh ton and an average productivity of 406.98 kg $ha^{-1}$ (Anon., 2013-14). The areas particularly Bidar and Gulbarga districts have an extensive cultivated area of greengram, pigeon pea and bengalgram. Hence these regions are called “Pulse bowl” of Karnataka. In Karnataka, it occupies an area of 3.19 lakh ha with a production of 0.81 lakh ton and an average yield of 267 kg $ha^{-1}$ (Anon., 2013-14). Greengram productivity may be improved through the application of macro and micronutrients. The importance of micronutrients particularly Fe, Zn, Mn and Co has been emphasized by Reddy and Raj (1975) in greengram. Poor productivity in greengram is also attributed to poor photosynthetic efficiency, lack of partitioning of photosynthates to pods and seed setting. The use of nutrients can improve the physiological efficiency of plants and offers sufficient role in increasing the crop yield.

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## MATERIALS AND METHODS

A field experiment was conducted during *Kharif*, 2014 at the Main Agriculture Research Station, UAS, Dharwad,

Karnataka, India. The experiment was laid out in RCBD with three replications. The gross plot size was 3.6 m × 4.2 m and net plot was 3.0 m × 3.6 m. The spacing adopted was 30 cm × 15 cm. There were nine treatments comprising of nutrients, fungicide and control *viz.,* $KNO_3$ (0.1 %), $MnSO_4$ (0.3 %), $ZnSO_4$ (0.5 %), $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %), $KNO_3$ (1.0 %) + $ZnSO_4$ (0.5 %), $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %), $KNO_3$ (1.0 %) + $MnSO_4$ (0.3%) + $ZnSO_4$ (0.5%), Propiconazole (0.1 %) and Control (unsprayed) applied as foliar spray twice at 35 and 50 days after sowing (DAS). Five plants were randomly selected from each plot and tagged for recording various observations at 45 DAS, 60 DAS and at harvest.

## RESULTS AND DISCUSSION

The effect of nutrients and fungicide on morphological characters like chlorophyll content, phenol content and peroxidase activity differed significantly at 45 DAS and 60 DAS due to the foliar sprays of nutrients and fungicide. The present data revealed significant differences in the chlorophyll contents due to treatments and the degree of powdery mildew infection. The increase in chlorophyll a, b and total chlorophyll contents occurred between 45 and 60 DAS. Bhat (1997) also reported decrease in chlorophyll due to the occurrence of late leaf spot in groundnut. The chlorophyll content did not differ significantly between the treatments at 45 DAS probably due to late spreading of the disease and delayed interaction with the nutrient treatments. However, at 60 DAS significant differences were found due to treatments of nutients for chlorophyll a, chlorophyll b and total chlorophyll. The data on chlorophyll content is presented in Table 1.

Chlorophyll 'a' content did not differed significantly at 45 DAS. However, it was higher 1.29 mg $g^{-1}$ fr. wt. in ($T_7$) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3%) + $ZnSO_4$ (0.5%) followed by ($T_2$) $MnSO_4$ (0.3 %). And in fungicide treatment the chlorophyll content was 1.27 mg $g^{-1}$ fr. wt. and it was least in control (1.17 mg $g^{-1}$ fr. wt.). At 45 DAS and 60 DAS significantly higher (0.82 and 0.90 mg $g^{-1}$fr.wt respectively) chlorophyll 'b' content was recorded in ($T_7$) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %). In fungicide treatment Propiconazole (0.1 %) chlorophyll 'b' content was 0.81 mg $g^{-1}$fr.wt and was on par with treatment ($T_1$) $KNO_3$ (1.0 %), ($T_2$) $MnSO_4$ (0.3 %), ($T_4$) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) and ($T_5$) $KNO_3$ (1.0 %) + $ZnSO_4$ (0.5%). Significantly lower (0.58 mg $g^{-1}$ fr.wt) chlorophyll 'b' content was recorded in control. Significantly lower content of chlorophyll a, chlorophyll b and total chlorophyll was noticed in the unsprayed control. Maximum chlorophyll a, b and total chlorophyll content was noticed in the treatment with $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) , $MnSO_4$ ( 0.3 %) and Propiconazole (0.1 %) . Singh *et al.* (1988) reported that foliar application of Fe, Mn and Mg (0.3 %, 0.5 % and 0.4 % respectively) reduced the chlorosis and increased chlorophyll in leaves of groundnut. At 60 DAS similar trend was continued with respect to total chlorophyll content in the leaves of greengram. The total chlorophyll content was significantly higher (2.32 mg $g^{-1}$fr.wt) in treatment ($T_7$) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) as compared to other treatments. Treatment ($T_1$) $KNO_3$ (1.0 %) and ($T_5$) $KNO_3$ (1.0 %) + $ZnSO_4$ (0.5%) were on par with each other. Fungicide treatment Propiconazole (0.1 %) recorded 1.97 mg $g^{-1}$fr.wt. of total chlorophyll content and was on par with the control (1.03 mg $g^{-1}$fr.wt). The data indicated that there is a direct role of iron and magnesium in the synthesis of chlorophyll. Mehta and Singh (1979) reported that the

**Table 1. Effect of nutrients on chlorophyll a, b and total chlorophyll content (mg $g^{-1}$ fr. wt.) content in greengram**

| Treatments | Chlorophyll 'a' | | Chlorophyll 'b' | | Total chlorophyll | |
|---|---|---|---|---|---|---|
| | 45 DAS | 60 DAS | 45 DAS | 60 DAS | 45 DAS | 60 DAS |
| $T_1$- $KNO_3$ (1.0%) | 1.17 | $1.26^{ab}$ | $0.76^{c}$ | $0.80^{ab}$ | $1.91^{bc}$ | $2.06^{abc}$ |
| $T_2$- $MnSO_4$ ( 0.3%) | 1.28 | $1.38^{a}$ | $0.80^{ab}$ | $0.86^{ab}$ | $2.03^{ab}$ | $2.23^{ab}$ |
| $T_3$- $ZnSO_4$ ( 0.5%) | 1.20 | $1.37^{a}$ | $0.75^{c}$ | $0.76^{b}$ | $1.92^{bc}$ | $2.13^{bcd}$ |
| $T_4$- $KNO_3$ (1.0%) + $MnSO_4$ ( 0.3%) | 1.24 | $1.23^{ab}$ | $0.76^{c}$ | $0.82^{ab}$ | $1.98^{b}$ | $2.01^{cd}$ |
| $T_5$- $KNO_3$ (1.0%) + $ZnSO_4$ ( 0.5%) | 1.19 | $1.29^{ab}$ | $0.75^{c}$ | $0.84^{ab}$ | $1.95^{bc}$ | $2.17^{abc}$ |
| $T_6$- $MnSO_4$ ( 0.3%) + $ZnSO_4$ (0.5%) | 1.26 | $1.24^{ab}$ | $0.77^{bc}$ | $0.78^{b}$ | $2.01^{b}$ | $1.99^{de}$ |
| $T_7$- $KNO_3$ (1.0%) + $MnSO_4$ ( 0.3%) + $ZnSO_4$ (0.5%) | 1.29 | $1.42^{a}$ | $0.82^{a}$ | $0.90^{a}$ | $2.11^{a}$ | $2.32^{a}$ |
| $T_8$- Propiconazole (0.1%) | 1.27 | $1.22^{ab}$ | $0.75^{c}$ | $0.81^{ab}$ | $1.96^{bc}$ | $1.97^{e}$ |
| $T_9$- Control | 1.17 | $0.48^{b}$ | $0.65^{d}$ | $0.58^{c}$ | $1.78^{c}$ | $1.03^{e}$ |
| Mean | 1.23 | 1.21 | 0.76 | 0.79 | 1.96 | 1.99 |
| SEm ± | 0.30 | 0.12 | 0.01 | 0.03 | 0.06 | 0.08 |
| LSD @ 0.05 | NS | 0.71 | 0.03 | 0.10 | 0.22 | 0.18 |

DAS - Days after sowing, NS - Non significant

Note: DMRT- values in the column followed by the same letter do not differ significantly

**Table 2. Effect of nutrients on phenol content (mg $g^{-1}$ fr. wt.) and peroxidase activity (ΔOD mg $protein^{-1}$ $min^{-1}$) in greengram**

| Treatments | Phenol content (mg $g^{-1}$ fr. wt.) | | Peroxidase activity (ΔOD mg $protein^{-1}$ $min^{-1}$) | |
|---|---|---|---|---|
| | 45 DAS | 60 DAS | 45 DAS | 60 DAS |
| $T_1$- $KNO_3$ (1.0%) | $0.730^{e}$ | $1.270^{c}$ | $0.110^{bc}$ | $0.130^{d}$ |
| $T_2$- $MnSO_4$ ( 0.3%) | $0.860^{a}$ | $1.360^{ab}$ | $0.120^{ab}$ | $0.150^{b}$ |
| $T_3$- $ZnSO_4$ ( 0.5%) | $0.850^{ab}$ | $1.350^{ab}$ | $0.100^{c}$ | $0.130^{d}$ |
| $T_4$- $KNO_3$ (1.0%) + $MnSO_4$ ( 0.3%) | $0.830^{b}$ | $1.300^{bc}$ | $0.110^{bc}$ | $0.120^{e}$ |
| $T_5$- $KNO_3$ (1.0%) + $ZnSO_4$ ( 0.5%) | $0.800^{c}$ | $1.190^{d}$ | $0.110^{bc}$ | $0.130^{d}$ |
| $T_6$- $MnSO_4$ ( 0.3%) + $ZnSO_4$ (0.5%) | $0.760^{d}$ | $1.330^{abc}$ | $0.110^{bc}$ | $0.140^{c}$ |
| $T_7$- $KNO_3$ (1.0%) + $MnSO_4$ ( 0.3%) + $ZnSO_4$ (0.5%) | $0.870^{a}$ | $1.370^{a}$ | $0.130^{a}$ | $0.160^{a}$ |
| $T_8$- Propiconazole (0.1%) | $0.760^{d}$ | $1.330^{abc}$ | $0.110^{bc}$ | $0.120^{e}$ |
| $T_9$- Control | $0.650^{f}$ | $1.070^{e}$ | $0.080^{d}$ | $0.110^{f}$ |
| Mean | 0.79 | 1.29 | 0.11 | 0.13 |
| SEm ± | 0.008 | 0.021 | 0.007 | 0.002 |
| LSD @ 0.05 | 0.022 | 0.057 | 0.016 | 0.007 |

DAS - Days after sowing

Note: DMRT- values in the column followed by the same letter do not differ significantly

application of elemental sulphur to blackgram in calcareous soil increased the chlorophyll content. The aromatic compounds such as mono and dihydric phenols, phenolic, glucosides, flavonoids, anthocyanins, aromatic amino acids and coumarin derivatives tend to increase in host tissues when invaded by a parasite. One of the major biological properties of phenolic compounds is their antimicrobial activity and is often assumed that, their main role in plants is to act as protective compounds against disease causing agents such as fungi, bacteria and viruses. Involvement of phenolic compounds in many aspects of plant parasite relationship has been also reported (Friend *et al.,* 1979). The phenolic contents increased as the growth advanced. Similar increase in phenolic content was observed by Friend *et al*. (1979) who indicated that phenolic compounds increase during infestation and were toxic to the pathogens. Phenolic contents differed significantly at 45 and 60 DAS and it increased from 45 to 60 DAS. Phenol content (mg $g^{-1}$fr.wt) and peroxidase activity (ΔOD mg $protein^{-1}min^{-1}$) recorded at 45 and 60 DAS in greengram and are presented in Table 2. The phenol content was significantly higher in ($T_7$) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) at 45 and 60 DAS *i.e ;* 0.87 and 1.37 mg $g^{-1}$fr.wt respectively, followed by ($T_2$) $MnSO_4$ (0.3 %) and were on par with each other. Other foliar nutrient treatments differed significantly with each other with respect to phenol content and were significantly higher compared to control. Significantly higher phenolic content was observed due to the application of nutrients as compared to control. Among the nutrient application $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) recorded significantly higher values for phenol content at both the stages as compared to other treatments. Munshi *et al.* (1987) recorded higher phenolic constituents in resistant cultivars of pea affected by powdery mildew than the susceptible cultivars. Manganese appears to be involved in atleast two steps in the biosynthetic pathways leading to lignin synthesis by utilizing phenols and its deficiency can increase susceptibility to pathogen invasion (Graham, 1983). Peroxidase activity generally catalyses a redox reaction between hydrogen peroxide ($H_2O_2$) as electron acceptor and many kind of substrates (phenolic substances, aromic amines, ascorbic acid, cytochrome C, $NADH_2$ etc.). one of the functions ascribed to peroxidase in the cell wall is its role in lignin formation (Stafford, 1965). Peroxidase activity increased from the 45 to 60 DAS along with an increase in the severity of disease in the crop. Arora and Bajaj (1985) was also same opinion as far as increase in the activity of peroxidase with infection of *Rhizoctonia solani* in mungbean. The peroxidase activity at 45 DAS was significantly higher (0.13 ΔOD mg $protein^{-1}$ $min^{-1}$) in ($T_7$) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %). Treatment ($T_1$) $KNO_3$ (1.0 %), ($T_2$) $MnSO_4$ (0.3 %), (T4) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %), ($T_5$) $KNO_3$ (1.0 %) + $ZnSO_4$ (0.5 %) and ($T_6$) $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) were on par with the fungicide treatment ($T_8$) *i.e.* propiconazole (0.1 %). The lowest (0.08 ΔOD mg $protein^{-1}$ $min^{-1}$) peroxidase activity was recorded in control. At 60 DAS significantly higher peroxidase activity noticed in the treatment ($T_7$) $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) + $ZnSO_4$ (0.5 %) compared to all other treatments. The activity was similar in the treatment ($T_1$) $KNO_3$ (1.0 %), ($T_3$) $ZnSO_4$ (0.5 %) and ($T_5$) $KNO_3$ (1.0 %) + $ZnSO_4$ (0.5 %) *i.e.* 0.13 ΔOD mg $protein^{-1}$ $min^{-1}$. In fungicide treatment ($T_8$) *i.e.* propiconazole (0.1 %) peroxidase activity was 0.12 ΔOD mg $protein^{-1}$ $min^{-1}$ and it was superior compared to control (0.11 ΔOD mg $protein^{-1}$ $min^{-1}$). Peroxidase activity at 60 DAS differed significantly among the treatments. The peroxidase activity was significantly higher due to application of $MnSO_4$ (0.3 %) individual, and its combinations with other nutrients $KNO_3$ (1.0 %) , $MnSO_4$ (0.3 %) and $ZnSO_4$ (0.5 %) and combination of $KNO_3$ (1.0 %) + $MnSO_4$ (0.3 %) along with higher incidence of diseases. However, the activity of peroxidase is lower with the individual application with $KNO_3$ (1.0 %) and $ZnSO_4$ (0.5 %). This indicates that there is no clear relationship between peroxidase activity and the disease resistance with the use of nutrients. It also indicates that there is differential mechanism of induction of disease resistance by using different nutrients and their combinations with other nutrients. The increased peroxidase activity in various host-parasite combinations may be associated with the disease resistance in the host plants, however, this is not inevitably so. Results from studying the role of peroxidase in resistance on susceptibility have been summarized in a number of reviews (Farkas and Kiraly, 1958, 1962; Tomiyama, 1963; Wood, 1967 and Kosuge, 1969).

It has been shown that, strong activation of peroxidase in rust resistant combinations is not the cause of resistance, but rather a non-availability response of the host plant (Frick, 1976).

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