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On Farm Testing on Foliar Application of Nutrients and Growth Regulators in Pigeonpea (*Cajanus cajan* L.)

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ABSTRACT

Background: Onfarm Testings were conducted to asses effect of TNAU Pulse wonder in pigeonpea variety LRG-52 in ten farmer's holdings of kurnool district during *kharif* from 2018-19 to 2020-21.

Methods: The experiment consisted of 7 technology options (treatments). T_1: consisting recommended dose of fertilizers along with spraying of pulse wonder @ 5 kg ha^{-1} during flowering and 15 days after 1st spray, T_2: 75% RDF + Pulse wonder @ 5 kg ha^{-1} at flowering, T_3: 50% RDF + Pulse wonder 5 kg ha^{-1} at flowering,T_4: 100% RDF+ 2% DAP at flowering and pod formation stage T_5: 100% RDF alone (20:50: 0 NPK kg ha^{-1}),T_6: Farmers practice (30: 60: 10 NPK kg ha^{-1}),T_7: Control. Data was analyzed using least significant difference in R software.

Result: The results revealed that the T_1 recorded the highest plant height (130,129,127 cm at flowering stage in 2018-19, 2019-20 and 2020-21 respectively). The lowest flower shedding observed in T_1 treatment while it was the highest under T_6 in all the three years of the study. Pod yield was the highest in T_1 (1889, 1870 and ,1873 kg ha^{-1} in 2018-19, 2019-2020 and 2020-21 respectively) and the lowest in T_7. The average highest benefit cost ratio (4.0) was realized in T_1 and lowest in farmers practice (T_6). Seed yield was positively correlated with number of flowers plant $^{-1}$ (r value 0.813, 0.762 and 0.735) and test weight (r value 0.795,0.8 and 0.754) and negatively correlated with flower shedding (r value -0.788,-0.712 and -0.750) in 2018-19, 2019-20 and 2020-21 years respectively. The final yield of crop is the cumulative effects of growth and yield attributes which manipulate the favorable parameters for higher yields.

Key words: Foliar sprays, On farm testings, Pulse wonder, RDF.

INTRODUCTION

Pigeon pea (*Cajanaus cajan*), also known as redgram or arhar or tur, is an annual legume from the family *Fabaceae.* Since its domestication in the Indian subcontinent 3500 years ago, its seeds have become a common food in Asia, Africa and Latin America and consumed on a large scale in South Asia. Thus it is a major source of protein for the population of the Indian sub-continent. Globally, redgram is grown in an area of 60.96 lakh hectares with a production of 50.12 lakh tonnes and productivity of 822.2 kg/ha (FAO STAT, 2020). India ranks first in redgram production globally with 42.8 lakh tonnes cultivated under 48.24 lakh hectares with productivity of 887 kg/hectare in 2020-21 (agricoop.nic.in). In *kharif* 2021-22, total produduction of redgram production was 44.3 lakh tonnes (1st advance estimates) from an estimated area of 50.02 lakh hectares (agricoop.nic). Andhra Pradesh produced 0.84 lakh tonnes contributing 1.96% to total India's production cultivated in an area of 2.31 lakh hectares with 363 kg/hectare productivity in 2020-21. Kurnool is the second largest area in Andhra Pradesh and mostly cultivated during *kharif* season under rainfed conditions an area of 71840 hectares and production of 19095 MT in the district (2021-22). (http://www.indiastat.com).

The productivity of pigeonpea in Andhra Pradesh is very low (536 kg/ha), compared to Bihar which is highest in productivity (1695 kg/ha). (DES, 2015-16). Thus there is need for enhancement of the productivity of pigeonpea by proper agronomic practices. One among them is foliar application of nutrient sources for exploiting genetic potential of the crop. This is considered to be an efficient and economic method of supplementing part of nutrients requirement of critical stages. Nutrients play a pivotal role in increasing seed yields in pigeonpea (Manonmani and Srimathi, 2009). Nutrient management in pigeonpea follows application as basal dose only which might be the requirement for first formed flowers. To exploit yield potential of the crop, the second formed fleshes also needs nourishment. This triggers the need to supplement the nutritional needs through other methods. One among them is foliar application of nutrients and growth regulators considered to be an efficient and economic method of

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supplementing part of nutrients requirement at critical stages. Foliar application is credited with the advantage of quick and efficient utilization of nutrients due to direct entry into the plants via cuticle or stomata besides reducing the losses through leaching and soil fixation (Manonmani and Srimathi, 2009). Foliar application of N at particular stage may solve the slow growth, nodule senescence and low seed yield of pulse without involving root absorption at critical stage (Devaraju and Senthivel 2018). Foliar application of nutrient and growth regulator at pre-flowering and flowering stage was seen on reduction in flower drop percentage in black gram (Ganapathy *et al*., 2008). To exploit yield potential of the crop, the second formed fleshes also need nourishment. Keeping this in view an onfarm study was planned with foliar spray of nutrients and growth regulators involving TNAU Pulse wonder and 2% DAP along with recommended dose of fertilizers during three *kharif* seasons from 2018-19 to 2020-21.

MATERIALS AND METHODS

Krishi Vigyan Kendra, Banavasi, carried out the study on the technologies in the farmers fields through 30 Onfarm testings during *kharif* season from 2018 to 2020 in the three mandals *viz*.,Yemmiganur, Adoni and kodumuru of Kurnool district in Andhra Pradesh. Farmers who are practicing indiscriminate and excess application of fertilizers were selected from different villages with same soil type. The experiment consisted of 7 technology options (treatments).

T_1: consisting recommended dose of fertilizers (20:50:0 NPK kg ha^{-1}) along with spraying of pulse wonder @ 5 kg ha-^{1} during flowering and 15 days after 1st spray, T_2 : 75% RDF + Pulse wonder 5 kg ha^{-1} at flowering, T_3 : 50% RDF + Pulse wonder 5 kg ha^{-1} at flowering, T_4 : 100% RDF+ 2% DAP at flowering and pod formation stage T_5 : 100% RDF alone (20:50: 0 NPK kg ha^{-1}), T_6: Farmers practice (30: 60: 10 NPK kg ha^{-1}), T_7: control. Pigeonpea variety LRG-52 was used for this study. Seeds were sown with the spacing of 90 × 20 cm. Recommended dose of fertilizers were calculated as per treatments were applied as basal. The required quantity of foliar nutrients and water for each plot were calculated to prepare solution and sprayed uniformly by hand sprayer using conical shaped nozzle. 2% DAP solution was prepared and sprayed during flowering and pod formation stages. TNAU Pulse wonder @ 5 kg ha^{-1} was sprayed during flowering stage. The pigeonpea crop was harvested, when the pods were fully ripened and turned brown. Threshed seeds were sun-dried for 2-3 days to reduce the moisture content and then the seed yield per plot was recorded. During these period regular visits by Krishi Vigyan Kendra, Banavasi Scientists to Onfarm testing plots were made to supervise important farm operations. The extension activities like training programmes, group meetings and field days were also organized at the demonstration sites as to provide opportunities for other farmers of that area to interact and to seek benefits from these demonstrations. Observations on growth, yield attributes and yield were analysed and expressed as means of three replicates (n) ± standard deviation. Data were statistically analyzed with R software. To elucidate significant differences between means ($p<0.05$), post hoc comparisons were made using Tukey's HSD. The correlation matrix was created using R studio version 1.4.1717 utilizing the 'ggcorrplot' package. Economics were calculated based on the prevailing market price of the vegetable cowpea and labour wages / man day. The input and output prices of the commodities prevailing during the study were taken into an account for calculating the net returns and benefit-cost ratio.

RESULTS AND DISCUSSION

Growth

Plant height and number of flowers per plant were significantly influenced by fertilizer levels and foliar spraying of pulse wonder and 2% DAP. In the year 2018-19 the application of 100 % recommended dose of fertilizers in combination pulse wonder @ 5 kg ha^{-1} during flowering and 15 days after 1st spray (T_1) recorded maximum plant height and number of flowers per plant which was significantly superior than rest of treatments, expect application of DAP @ 1% flowering and 15 days after 1st spray (T_4). The minimum height of the plant height and number of flowers per plant were recorded in control treatment. (Table 1). The flower shedding was lowest in T_1 and maximum flower shedding was observed in T_7 (Fig 1). Same trend was also observed in the years 2019-20 and 2020-21 (Table 2 and 3) The significant increase of plant height was due to the inter node elongation and the vigorous root growth of the crop. This might be due to better absorption of nutrients applied through foliage leading to better activity of functional root nodules resulting in more leaf area, dry matter production and uptake of nutrients. This could have led to more flower

Table 1: Effect of different treatments on growth and yield parameters of pigeonpea in 2018-19.

Treatments	Plant height (cm)	No of flowers/plant	flower shedding (%)	Test weight (gm)	Pod yield (kg/ha)
T1	130.09±11.23^{a}	147.9±1.79^{a}	20.73±1.03^{e}	4.04±0.3^{a}	1889.26±21.45^{a}
T2	120.85±5.65^{bcd}	138.22±1.31^{b}	27.56±1.77^{d}	3.25±0.17^{c}	1796.6±27.23^{c}
T3	122.46±5.04^{bc}	109.53±3.8^{d}	32.04±1.57^{c}	2.93±0.26^{d}	1727.22±15.74^{d}
T4	125.32±6.6^{ab}	145.32±4.37^{a}	27±1.33^{d}	3.49±0.09^{b}	1874.22±15.71^{a}
T5	115.87±6.96^{d}	128.43±1.57^{c}	36.29±0.63^{b}	3.11±0.37^{cd}	1833.07±9.74^{b}
T6	122.93±6.39^{bc}	107.93±3.72^{d}	37.14±1.52^{b}	2.9±0.31^{d}	1661±8.39^{e}
T7	116.72±3.74^{cd}	97.3±4.22^{e}	42.96±1.7^{a}	2.47±0.09^{e}	1169.22±23.5^{f}

production and subsequently low flower shedding .The application of TNAU pulse wonder and DAP as foliar spray significantly improves the yield attributing characters by reducing flower shedding and resulted in increse number of pods/plant (Ravisankar *et al*., 2003 and Babu, 2003).

Yield and yield attributes

Foliar application of pulse wonder @ 5 kg/ha at flowering and 15 days after the 1st spray of crop growth resulted in significantly highest test weight and seed yield than other foliar spray treatments . The yield was however onpar with T_4 (100% RDF+ 2% DAP at flowering and pod formation stage) in the year 2018-19. (Table 1). Similar results were obtained in the years 2019-20 and 2020-21 (Table 2 and 3). The increase in yield might be due to reduce in flower shedding. Higher availability nutrients at flower initiation and pod formation stages of crop growth and efficient translocation of photosynthates from source to sink. It is due to increased uptake of nutrients by pieonpea by effective translocation of nutrients from sink to reproductive area of crop. The results are also in accordance with (Kavitha *et al*., 2019).

Correlation analysis

The correlation heat maps present the types of correlations between the different pigeonpea growth and yield parameters (Fig 2, 3 and 4). It appears that some parameters are either positively or negatively correlated to others with positive values dark red and the negative values in blue. The strongest correlations are obtained between PY and FP, TW and PH. This implies that value increase of one of this parameter leads to the increase of the parameter to which it is significantly correlated. The strongest negative correlation is between PY and FS. Pod yield was positively correlated with number of flowers $plant^{-1}$ (r value 0.813, 0.762 and 0.735) and test weight (r value 0.795, 0.8 and 0.754) and negatively correlated with flower shedding. (r value

Table 2: Effect of different treatments on growth and yield parameters of pigeonpea in 2019-20.

Treatments	Plant height (cm)	No. of flowers/plant	Flower shedding (%) 2019-20	Test weight (gm)	Pod yield (kg/ha)
T1	129.3±6.5[a]	147.37±1.56[a]	20.49±0.67[f]	3.96±0.28[a]	1870.69±12.57[a]
T2	118.89±6.61[c]	136.53±1.42[b]	27±1.41[e]	3.23±0.15[bc]	1781.29±17.16[c]
T3	121.91±5.86[bc]	105.83±4.23[d]	33.08±1.53[d]	2.91±0.24[d]	1710.26±9.18[d]
T4	124.79±6.3[ab]	144.38±2.5[a]	26.34±1.15[e]	3.45±0.14[b]	1866.21±14.27[a]
T5	118.54±6.58[c]	124.94±2.73[c]	36.53±1.06[c]	3.11±0.37[cd]	1829.25±14.23[b]
T6	121.24±4.99[bc]	105.06±6.6[d]	37.8±1.23[b]	2.9±0.31[d]	1661.51±9.36[e]
T7	111.63±2.68[d]	97.94±5.61[e]	41.07±0.95[a]	2.47±0.09[e]	1169.03±38.93[f]

Table 3: Effect of different treatments on growth and yield parameters of pigeonpea in 2020-21.

Treatments	Plant height (cm)	No. of flowers/plant	Flower shedding (%)	Test weight (gm)	Pod yield kg/ha
T1	127.54±8.78[a]	146.98±1.63[a]	20.98±0.82[f]	3.97±0.34[a]	1873.17±12.18[a]
T2	124.53±11.6[ab]	138.63±1.77[b]	27.22±1.31[e]	3.2±0.13[c]	1775.75±15.02[c]
T3	122.41±6.5[ab]	106.94±5.2[d]	32±1.15[d]	2.88±0.27[d]	1711.42±8.39[d]
T4	126.28±8.2[a]	146.04±2.26[a]	26.63±1.41[e]	3.47±0.12[b]	1862.72±17.71[a]
T5	118.64±4.57[bc]	123.93±3.59[c]	36.83±1[c]	3.02±0.37[cd]	1823.52±11.61[b]
T6	118.25±4.67[bc]	105.76±5.44[d]	38.24±0.62[b]	2.95±0.3[d]	1659.73±7.82[e]
T7	115.67±2.49[c]	100.18±5.47[e]	42.63±1.56[a]	2.52±0.15[e]	1150.32±33.87[f]

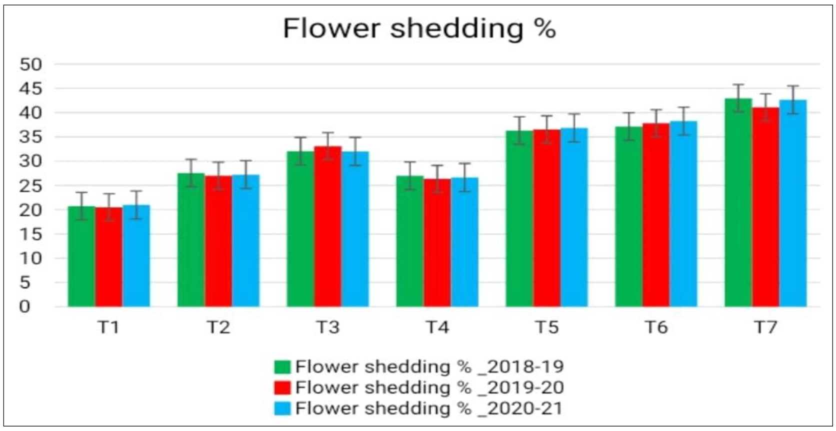
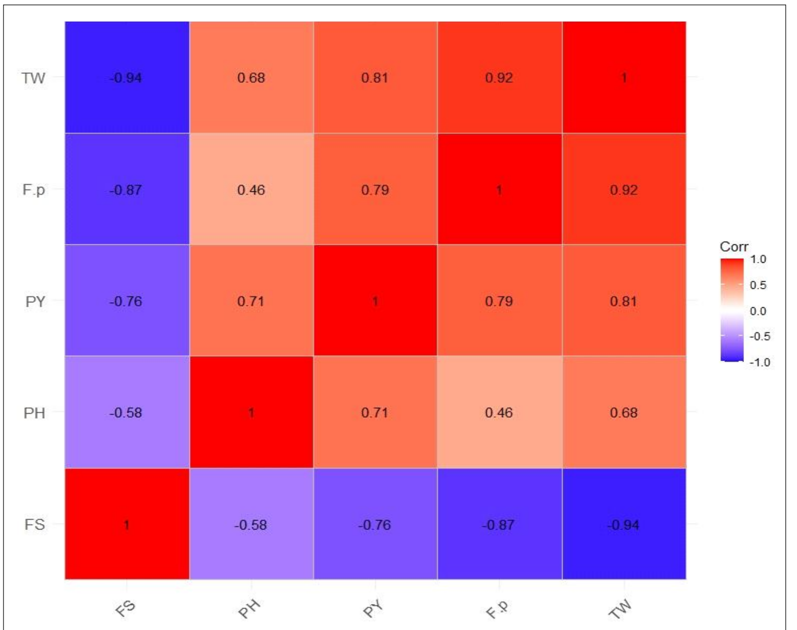


Fig 1: Effect of different nutrient management practices on flower shedding from 2018-19 to 2020-21.

-0.788,-0.712 and -0.750) in 2018-19,2019-20 and 2020-21 years respectively. This indicates lower flower shedding significantly increases the yield. This trend was observed in all the three years of the experiment.

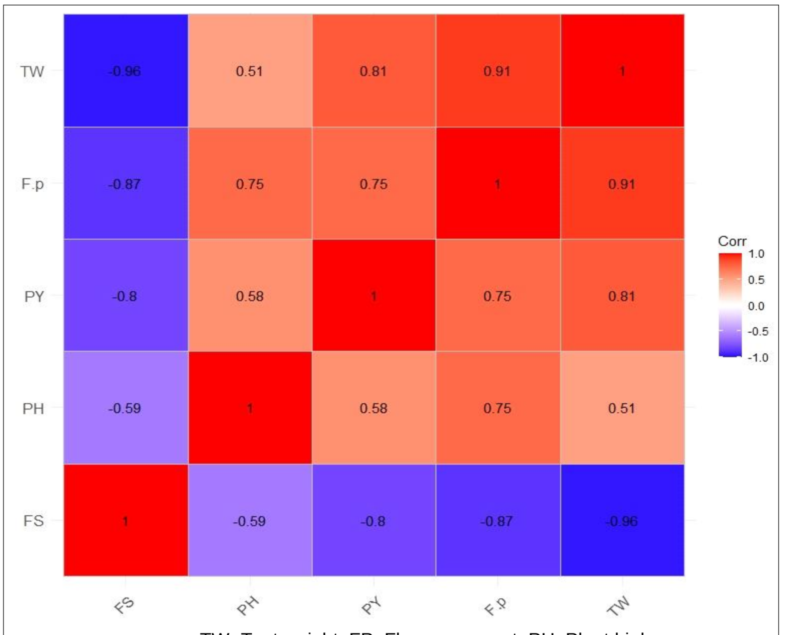
Regression analysis

Quadratic response regression analysis on the grain yield of pigeonpea was predicted for the impact of number of flowers per plant and test weight the results indicated that the increase in these parameters has significant effect on grain yield of pigeonpea , as shown in the graph with the R^2 value and polynomial equation (Fig 5 and 6). For instance polynomial equation Pod yield kg/ha = 440.21094+10.14035 *No of flowers/plant with the R^2 value of 0.6608 was observed for number of flowers per plant with grain yield in the year 2018-19. Similar trend was observed with other parameters



TW: Test weight; FP: Flower per pant; PH: Plant High;
PY: Pod yield; FS: Flower shedding.

Fig 2: Correlation heat map between growth and pigeon pea yield parameters in the year 2018-19.



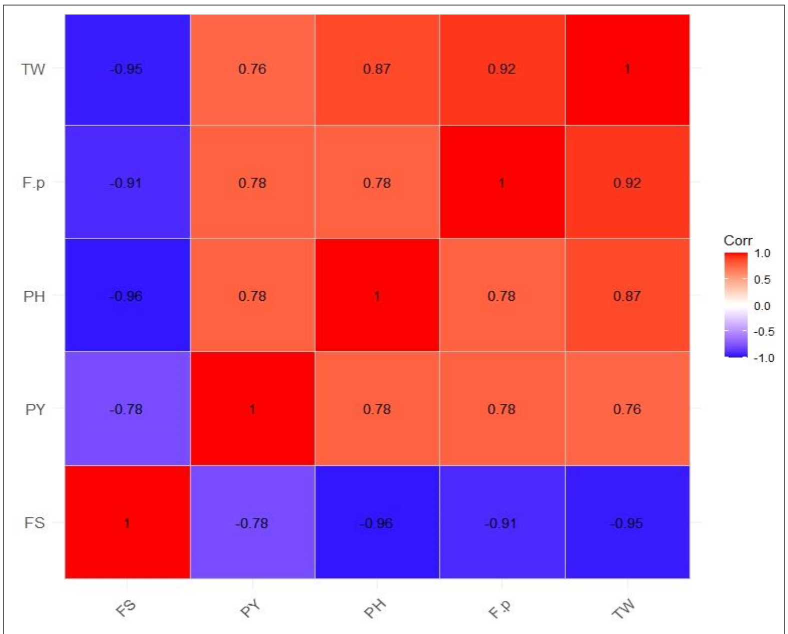
TW: Test weight; FP: Flower per pant; PH: Plant high;
PY: Pod yield; FS: Flower shedding.

Fig 3: Correlation heat map between growth and pigeon pea yield parameters in the year 2019-20.

(test weight with Fig 4 and 5). The final yield of crop is the cumulative effects of growth attributes. The treatments which promote the favorable parameters could result in the positive relationship with higher productivity as observed in the current study. Similar findings were recorded in blackgram by Marimuthu and Surendranin (2015).

Economics

Foliar application of pulse wonder @ 5 kg/ha flowering and 15 days after 1st DAS spray (T_1) recorded higher average benefit: cost ratio of 4.01 followed by application of 100% RDF+ 2% DAP at flowering and pod formation stage (T_4) (Fig 7). Some of the earlier study also reported that foliar spray of pulse wonder DAP, NAA and



TW: Test weight; FP: Flower per pant; PH: Plant high;
PY: Pod yield; FS: Flower shedding.

Fig 4: Correlation heat map between growth and pigeon pea yield parameters in the year 2020-21.

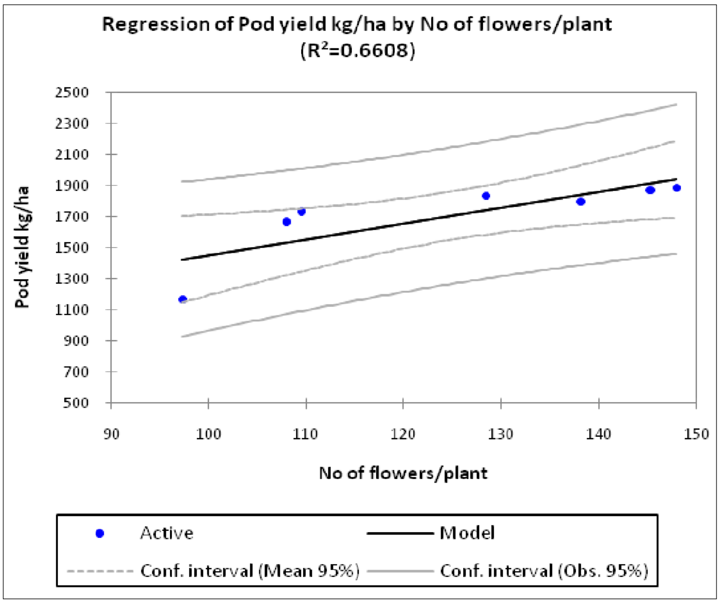


Fig 5: Linear regression between pigeonpea yield and No of flowers per plant in 2018-19.

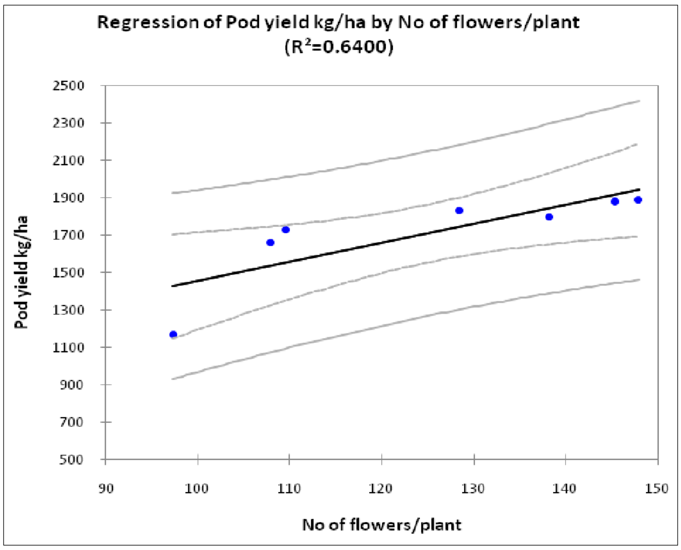


Fig 6: Linear regression between pigeonpea yield and No of flowers per plant in 2019-20.

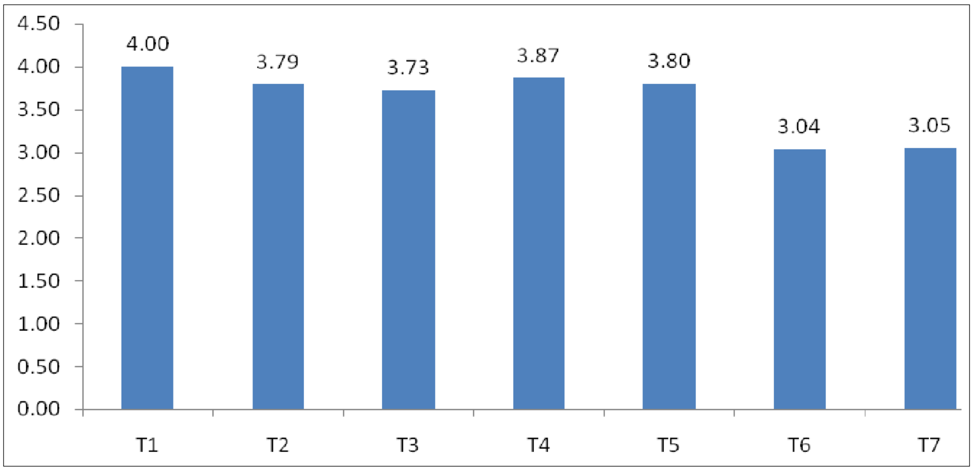


Fig 7: Benefit-cost ratio between different treatments.

micronutrients significantly improved seed yield of green gram and highest benefit cost ratio (Marimuthu and Surendran 2015). The lowest benefit: cost ratio of 3.04 was recorded in a farmer's practice T6 (30 :60: 10 NPK kg ha^{-1}).

CONCLUSION

The present investigation concluded that application of foliar application of TNAU pulse wonder @ 5 kg/ha at flowering and 15 days after 1st spray can be recommended to realize the genetic potential of the variety under test with higher profitability of pigeonpea in Scarce Rainfall Zone of Andhra Pradesh, India.

Conflict of interest: None.

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