INFLUENCE OF SMART FERTILIZER ON YIELD AND ECONOMICS OF COWPEA

ABSTRACT

The extent of agricultural land under cultivation is diminishing continuously as a result of improper over use of fertilizer leads to environmental contamination and productivity of land is also become diminished. Nonetheless, in order to fulfill the rising population's nutritional needs as well as those of the developing industry, agricultural production must be enhanced. Smart fertilizers like nano fertilizers are the new technologies to enhance the nutrient use efficiency their by improving crop yield in sustainable manner. Nano-fertilizers are the nano-particles-based fertilizers, where supply of the nutrients is made precisely for maximum plant growth, have higher use efficiency, exploiting plant unavailable nutrients in the rhizosphere and can be delivered on real time basis into the rhizosphere or by foliar spray. Pulses are gaining more important position in Indian agriculture. But the average productivity of pulses is pulses in India (764 kg ha^{-1}) is far below the average productivity of the world (848 kg ha^{-1}). Basally applied nutrients are lost over time, thus applying important fertiliser to cowpeas during their critical growth is a effective strategy to enhance their yield. Especially smart fertilizers like Nano Diammonium Phosphate (DAP) and Zinc - Ethylene Diamine Tetra Acetic Acid (Zn EDTA) are very helpful in that.Therefore the, field experiment was done in the School of Agriculture and Animal Science, Gandhigram Rural Institute, Gandhigram, Tamil Nadu during January 2024 to April 2024 to assess the impact of Nano DAP and Zn EDTA on growth and yield of cowpea. There were seven treatments with three replications that were laid out in RBD. Among the different treatments, RDF 50% P, 100% NK + Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) was achieved a supremely improved growth parameters and yield attributes and yield. Experimental results clearly revealed that RDF 50% P, 100% NK + Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA(T_7) has recorded the highest grain yield of 1720 kg ha^{-1} and BCR of 3.25.

Key words: Nano DAP, Zn EDTA, Cowpea,Yield parameters,Economics.

Introduction:

Pulses are the most important source of dietary protein and also can maintain or restore soil fertility through fixing nitrogen biologically as well as by adding considerable amount of residue to the soil . Among various legumes cowpea (*Vigna unguiculata* L.) is a very important pulse crop in our country specially for household consumption (Panda *et al*.,2017). It is an annual herbaceous legume crop from the genus Vigna and family "Fabaceae" or Leguminosae (Dorjee *et al*.,2020). It can fix atmospheric nitrogen and also can supply it to the soil at the rate of 56 kg ha^{-1} in association with symbiotic bacteria (rhizobium) under suitable conditions (Eke *et al*.,,1999 , Fatokum *et al*.,2000).Cowpea is often referred as Vegetable meat.100 g of green tender pods contain 4.3 g protein, 2.0 fibre, 8.0 g carbodydrates, 74 mg phosphorus, 2.5 mg iron, 13.0 mg vitamin-C,0.9 mg minerals, etc.Due to its nutritive value and soil improving properties, it is also used as a fodder, green manure and cover crop. Being a legume crop, cow pea fits well in inter-cropping system.But besides its importance, Production and productivity of pulses is low in India due to cultivation of pulses in marginal and sub marginal soils with poor management practices.To ensure self sufficiency, the projected demand of pulses is 39 million tonnes by 2050 which necessitates an annual growth rate of 2.14% (IIPR).To improve its production and productivity,nutrient management strategies like foliar application of important nutrients is a feasible one. Cowpea is highly response to fertilizer application.

.Legumes are phosphorus loving crops and Phosphorus is essential for nodules formation (Haruna and Aliyu, 2011), flowers initiation and seed development (Ndakemi and Dakora, 2007). Among micronutrient, Zn plays an important role in plant growth and development. In developing countries, Zn deficiency occurs due to inadequate supply of micronutrient. Several research findings also reported that, considerable increase in the yield of the crop due to the application of Zn fertilizers.In the modern era , the smart fertilizers like Nano DAP and Zn EDTA are going to play an important role to enhance the agriculture production. Smart fertilizers like slow and controlled release fertilizers, nano fertilizers and bioformulation fertilizers are the new technologies to enhance the nutrient use efficiency their by improving crop yield in sustainable manner. The use of slow and controlled release fertilizers increase nutrient use efficiency, minimize the risks like leaf burning, water contamination and eutrophication. Nano-fertilizers are the nano-particles-based fertilizers, where supply of the nutrients is made precisely for maximum plant growth, have higher use efficiency, exploiting plant unavailable nutrients in the rhizosphere and can be delivered on real time basis into the rhizosphere or by foliar spray (Solanki *et al.*, 2015). Keep the above points in view that, the study was carried out to analyse the effect of Nano DAP and Zn EDTA on growth and yield of Cowpea with the following objectives.

Materials and methods

The study was conducted in 2024 for the yield and economics of cowpea as influenced by the Nano DAP and zinc EDTA at the dairy Farm, School of Agriculture and Animal Science, Gandhigram Rural Institute,Gandhigram, Tamil Nadu. The experimental farmwas located at 10.28° Nlatitude and 77.93°E longitude.The climate is moderately warm.Minimum and maximum temperature is around 26 °C to 38 °C.The relative humidity ranges from 51 to 79 % with mean annual rainfall of 850 mm.The soil of the experimental field were clay sandy loamy in texture with available nitrogen (185.5 kg ha^{-1}), phosphorus (20.50 kg ha^{-1}) and potassium(388.5 kg ha^{-1}). The experiment comprised of seven treatments which are in combination with ZN EDTA and Nano DAP.Plot size were 5 × 4 m .The details of the treatment were., T_1 – Control, T_2 – RDF 100% NPK (N- 12.5kg/ha, P_2O_5- 30Kg/ha , K_2O -16.7Kg/ha), T_3 – RDF 100%NPK+ Foliar spray of 3% Zn EDTA, T_4 – RDF 25%P, 100% NK + Seed treatment and two foliar spray of 0.2% Nano DAP, T_5 - RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP, T_6 – RDF 25% P, 100% NK+ Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA, T_7 – RDF 50% P, 100% NK + Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA.It was foliar sprayed at the 45 DAS and 60 DAS.It was laid out in the randomized block design with three replication.The test variety was CO (CP)7 and its spacing was 45 × 15 cm. Five plants were selected from each plot at random. Each plant marked with a small plastic white coloured tag and with wooden peg nearby for demarcation. The same five plants were observed at various stages of crop growth up to harvest for biometric observations. These five plants were harvested separately for post-harvest operations.

Results and discussion

Number of branches per plant

Tiny size of nano DAP helps absorb nutrients directly into the leaves, where nutrients can be absorbed more quickly and efficiently, adequate nutrients can lead to increased cell division and elongation. Nutrient uptake in plants increases with more branches per plant. Similar observations were recorded by Vaghar *et al.*, (2020) and Manjunath Gondi (2018).

Among the treatments, RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) was recorded the maximum branches of 7.92 . It is followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5) .The least branches of 5.3 was observed at the harvesting stage in the control treatment (T_1).

Number of pods per plant

In addition to combined application of conventional and nano DAP ensured optimum and balanced nutrient availability throughout the crop period especially during the critical stages of crop. This is due to smaller size and larger effective surface area of nano particles which can easily penetrate into the plant and lead to better uptake of nitrogen and phosphorous. The higher uptake results in optimal growth of plant parts. Similar results were reported by Manjili *et al.*, 2014 and Abdelghany *et al.*, 2022.

Zinc application to crops enhanced the nutrient metabolism, biological activity and growth parameters and hence, applied zinc resulted in higher enzyme activity which in turn encourage vegetative branches and pods plant^{-1}(Michail *et al.*, 2004). The cumulative effect of growth parameters, yield attributes and higher nutrient uptake by cowpea increased the seed yield (Channabasappa *et al.*, 2004).

The maximum no.of pods of 19.10 was noted in RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) at harvesting stage. This treatment was followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5). The least no.of pods per plant of 13.67 at harvesting stage was recorded in the control treatment (T_1).

Pod length

The application of 100% NK+75% P+2 foliar sprays of nano-P at the tillering and panicle initiation stages proved more effective for achieving higher growth, yield and yield attributing properties, and saved DAP if two foliar sprays of nano-P were applied at the tillering and panicle initiation stages as a form of phosphorus. Additionally, it can be a suitable substitute for 25% recommendation dose P for wheat crop cultivation under semi-arid climate(Poudel *et al.*, 2023).

In addition, the simultaneous application oftraditional and nano DAP ensured optimum andbalanced nutrient availability during the cropseason, particularly in the crucial stages of thecrop. This is because of the nanoparticles'smaller size and greater effective surface area,which allow them to enter the plant more readilyand improve nitrogen and phosphorus uptake.Plant components grow to theirmaximum potential as a result of the increasedabsorption. Similar results were reported byManjili *et al*.2014 and Abdelghany *et al*.2022.

Pod length was markedly influenced by the foliar application of Nano DAP and Zn EDTA fertilization.The maximum pod length of 16.93cm was noted in RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) at harvesting stage. This treatment was followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5). The least pod length of 12.10 at harvesting stage was recorded in the control treatment (T_1).

Number of seeds per pod

Growth and yield parameters increased significantly with increasing levels of phosphorus up to 90 kg ha^{-1}. However, growth and yield parameters of chickpea were increased up to 5 kg Zn ha^{-1} and further increase in the level of Zn does not show significant influence on growth and yield of chickpea. Interaction effect of P and Zn levels on the grain and straw yield of chickpea was significant during study. Thus, it may be concluded that application of phosphorus and zinc proved more beneficial in improving the productivity of chickpea crop. The result showed that application of P and Zn also improved the growth and yield (Singh *et al.*, 2024).

A higher number of seeds per plant was recorded in 50% of the recommended dose of Phosphorus and 100% of the recommended dose of Nitrogen and potassium + Seed treatment and two foliar applications of Nano DAP @ 0.2% + Foliar application of Zn EDTA @ 3% (T7).

Zinc application to crops enhanced the cumulative effect of growth parameters, yield attributes, and higher nutrient uptake by cowpeas increased the seed yield (Channabasappa *et al.*, 2004).

Foliar application of Nano DAP and Zn EDTA fertilization play a significant role .RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) was registered the highest seeds per pod of 13.6 at the harvesting stage. It is followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5). The control treatment (T_1) registered the least seeds per pod of 9.13.

Test weight

Adhikari *et al*., (2014) speculated that the yield of grain and straw increment over 100 RDF due to better absorption, interception and utilization of P in the nano-P form as P is released slowly throughout the growth period, resulting in a higher photosynthetic rate and ultimately, a higher yield parameters. Liu and Lal (2015) reported that the application of nano-particle fertilizer resulted in increased growth rate by 32.6% and seed production by 20.4% in comparison to no nano-fertilizer.

In immature cells with high metabolism and rapid cell division including shoot and root tips, it is essential in enormous amounts. It also promotes the growth of seeds, fruits and flowers (Nkaa *et al*.,2014).

Application of nano DAP and Zinc EDTA did not exert a significant influence on the test weight of cowpea. However, RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) was registered the maximum test weight of 13.90 g. This treatment was followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5). The least test weight of 13.78 g was noted in the control treatment (T_1).

Seed yield

Higher grain yield might be attributed to higher yield components. In addition to combined application of conventional and nano fertilizers (nano urea and DAP) ensured optimum and balanced nutrient availability throughout the crop period especially during the critical stages of crop. This is due to smaller size and larger effective surface area of nano particles which can easily penetrate into the plant and lead to better uptake of nitrogen and phosphorous. The higher uptake results in optimal growth of plant parts and metabolic processes like photosynthesis that increase photosynthates accumulation and translocation to the economically productive parts of the plant which results in increased biomass, yield attributing characters and finally yield by amplifying the translocation of assimilates to seeds. Similar results were reported by Bhargavi and Sundari (2023) and Rajesh (2021).

Significant enhancement in grain and straw yield of cow pea due to Zn foliar application which might be related to its role in photosynthesis, division of cell, synthesis of protein, retention of membrane structure along with the ability to provide resistance against pathogens. Another reason for increased yield was related to the role of Zn in the synthesis of carbohydrates, lipids and nucleic acid as these are considered crucial for the adequate growth and development of plants.Further, the proper functioning of pollen, fertilization and germination due to Zn foliar application (cakmak *et al*., 2008, Aravind, P., & Prasad (2003),Pandey (2012) automatically resulted in enhanced crop performance with improved yield.

The substantial grain yield increase with Nano-DAP application, especially when combined with conventional fertilizer, stores essential nutrients in plant cells, releasing them gradually to counter biotic and abiotic stress and boost grain production. Nano fertilizers promote rapid plant growth and metabolic processes, such as photosynthesis, leading to increased photosynthate accumulation and translocation to vital plant parts.Similar outcomes were reported by El-Azizy *et al*., (2021) demonstrating the efficacy of nano phosphorus fertilizer in increasing seed yield.

The efficacy of soil fertilizer application is lower than that of foliar fertilization under various environmental conditions, due to the direct provision of necessary nutrients to the leaves, relatively quicker absorption, independence of root activity, and soil water availability results in increased growth parameters of the plant (Poudel *et al*., 2023).

The data regarding the seed yield indicated that foliar application of Nano DAP and Zn EDTA fertilization achieved a markedly significant influence on it. The maximum seed yield of 1720 kg ha^{-1} was achieved by the RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7). It is followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5). The control treatment (T_1) resulted in the lowest seed yield of 710 kg ha^{-1}.

Haulm yield

Among the treatments, RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) at harvesting stage recorded the supremely highest haulm yield of 3670 kg ha-1. It is followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5).Likewise, the increase in haulm production with the foliar spray of nano fertilizers might be credited to nano fertilizers because of the rapid uptake of nano fertilizers by the plant and ease of translocation which assisted in a quicker rate of photosynthesis and more dry matter accumulation, resulting in a higher haulm yield. This is in conformity with the results of Mallikarjuna (2021) and Rajput *et al*., (2022).The least haulm yield of 2105 kg ha^{-1} was observed in the control treatment (T_1).

Harvest index

Tiny size of nano fertilizers results in better absorption of nano nutrients which affects plant growth mechanisms. Plant metabolic activities such as chlorophyll synthesis and photosynthetic activity both of which enhance vegetative growth increased due to proper supply of nutrients and accumulation of dry matter in leaves helped, the photosynthetic area to remain active for, longer period and was responsible for overall growth of plant in terms of harvest index. Similar observations were recorded by Sharma *et al*., (2022) and Maheta *et al*., (2023).

Harvest index was significantly influenced by the foliar application of Nano DAP and Zn EDTA fertilization. The registered harvest index values were given in table 1. The significantly highest harvest index of 31.91 was noticed in the RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) . It is followed by the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5). The lesser harvest index of 25.22 was noted in the control treatment (T_1).

Economics

Chinnappa *et al*.,(2023) revealed that application of 75% RNP as basal + nano urea & DAP spray @ 1.5 ml l^{-1} each at 30 and 45 DAS has produced significantly higher plant height and dry matter accumulation. It has resulted in enhanced grain yield (3281 kg ha^{-1}) by 120.6% over absolute control (1487 kg ha^{-1}). It was profitable too in terms of higher net returns (Rs. 84,319 ha^{-1}) and B C ratio (2.99) of sorghum production.

The maximum gross income of Rs. 137600/- ha^{-1}, net income of Rs. 104079/- ha^{-1} and benefit-cost ratio of 3.25 was achieved by the RDF 50% P, 100% NK + Seed treatment and two foliar spray 0. 2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7). It was followed by the the RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP (T_5). Among the treatments, the control treatment registered the least gross income of Rs. 56800/- ha^{-1}, net income of Rs. 29278/- ha^{-1} and benefit-cost Ratio of 1.06.

Table 1 : Effect of Nano DAP and Zn EDTA on yield attributes of cowpea

Treatments	No.of pods per plant	Pod length (cm)	No.of seeds per pod	Test weight (g)
T_1 – Control	13.67	12.11	9.13	13.78

T_2 – RDF 100% NPK (N-12.5kg/ha, P_2O_5- 30Kg/ha , K_2O -16.7Kg/ha)	16.61	14.80	11.87	13.85
T_3 – RDF 100% NPK+ Foliar spray of 3% Zn EDTA	17.40	15.53	12.39	13.85
T_4 – RDF 25%P, 100% NK + Seed treatment and two foliar spray of 0.2% Nano DAP	14.92	13.35	10.56	13.81
T_5 - RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP	18.31	16.25	13.02	13.88
T_6 – RDF 25% P, 100% NK+ Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA	15.77	14.15	11.21	13.83
T_7 – RDF 50% P, 100% NK + Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA	19.10	16.93	13.6	13.90
S.Ed	0.35	0.30	0.23	0.29
CD (P = 0.05)	0.76	0.63	0.51	NS

Table 2 Effect of Nano DAP and Zn EDTA on yield of cowpea

Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index

T_1 – Control	710	2105	25.22
T_2 – RDF 100% NPK (N-12.5kg/ha, P_2O_5- 30Kg/ha , K_2O -16.7Kg/ha)	1447	3111	31.74
T_3 – RDF 100% NPK+ Foliar spray of 3% Zn EDTA	1545	3315	31.79
T_4 – RDF 25%P, 100% NK + Seed treatment and two foliar spray of 0.2% Nano DAP	1279	2783	31.48
T_5 - RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP	1628	3508	31.69
T_6 – RDF 25% P, 100% NK+ Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA	1358	2949	31.53
T_7 – RDF 50% P, 100% NK + Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA	1720	3670	31.91
S.Ed	33	74	0.04
CD (P = 0.05)	68	151	0.11

Table 3 Effect of Nano DAP and Zn EDTAon economics of cowpea

Treatments	Cost of Cultivation (Rs.ha^{-1})	Gross income (Rs.ha^{-1})	Net Income (Rs.ha^{-1})	BCR

T_1 – Control	27522	56800	29278	1.06
T_2 – RDF 100% NPK (N-12.5kg/ha, P_2O_5- 30Kg/ha , K_2O -16.7Kg/ha)	28611	115760	87149	3.04
T_3 – RDF 100% NPK+ Foliar spray of 3% Zn EDTA	31226	123600	92374	2.95
T_4 – RDF 25%P, 100% NK + Seed treatment and two foliar spray of 0.2% Nano DAP	30794	102320	71526	2.32
T_5 - RDF 50% P, 100% NK+ Seed treatment and two foliar spray of 0.2% Nano DAP	30906	130240	99334	3.21
T_6 – RDF 25% P, 100% NK+ Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA	33409	108640	75231	2.25
T_7 – RDF 50% P, 100% NK + Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA	33521	137600	104079	3.25

Conclusion:

Based on the above results, it can be concluded that RDF 50% P, 100% NK + Seed treatment and two foliar spray 0.2% of Nano DAP + Foliar spray of 3% Zn EDTA (T_7) was recorded highest No.of pods per plant,pod length,No.of seeds per pod,testweight,grain yield,straw yield,Harvest index and BCR.

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