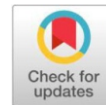


Original Research Article

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Response of nano dap on growth, yield and economics of cowpea (*Vigna unguiculata* L.)S. N. Goplani*¹, A. M. Polara², M. P. Dobariya¹, N. H. Solanki¹¹Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujarat, India²Department of Agronomy, Cotton Research Station, J.A.U., Junagadh, Gujarat, India**ABSTRACT**

A field experiment entitled "Response of nano dap on growth, yield and economics of cowpea (*Vigna unguiculata* L.)" was carried out on medium black calcareous soil during the summer season of 2024 at Cotton Research Station, Junagadh Agricultural University, Junagadh located in the South Saurashtra Agro-climatic Zone of Gujarat. The experiment was laid out in a randomized block design with three replications. The experiment comprised 10 treatments in combination of soil application, seed treatment and foliar application with conventional fertilizer and nano DAP. Among these treatments, the application of 100% RDF recorded significantly higher values of growth parameters viz., number of root nodules per plant (25.19), dry weight of root nodules per plant (376.42 mg) at 40 DAS. While application of 75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS recorded significantly higher values for plant height (52.50 cm) at 60 DAS, dry matter accumulation per plant (27.43 g) and number of branches per plant (7.33) at harvest. Application of treatment 75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS significantly promoted yield attributes and yield viz., number pods per plant (38.60), number of seeds per pod (12.95), length of pod (15.93 cm), seed yield (1341 kg/ha), stover yield (2660 kg/ha) and biological yield (4001 kg/ha). Economic analysis showed that the maximum net return (₹ 65030 /ha) and BCR (2.59) were obtained with the application of 75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS over control which was closely followed treatment 75% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS and 40 DAS) and 100% RDF.

Keywords: Nano DAP, Cowpea, Foliar Spray, Growth, Yield and Economics.

Introduction

Cowpea (*Vigna unguiculata* L.), belongs to the family Papilionaceae (Fabaceae or Leguminosae), originated in Sub-Saharan Africa [3]. This widely cultivated and adapted crop is of great importance in the tropical and subtropical countries of Asia, Oceania, the Middle East, Southern Europe, Africa, Southern United States of America, Central and South America [2]. Cowpea is commonly known as black-eyed pea, china pea, marble pea and southern pea.

Cowpea grains play an important role in the Indian diet; it also called "vegetable meat" due to high amount of protein which has better biological value. The mature cowpea seed contains about 24.8 per cent protein, 63.6 per cent carbohydrate, 1.9 per cent fat, 6.3 per cent fiber, 0.00074 per cent thiamine, 0.00042 per cent riboflavin and 0.00281 per cent niacin as well as rich source of calcium and iron [11].

Cowpea has a remarkable ability to fix atmospheric nitrogen through a symbiotic relationship with rhizobia bacteria. This process, known as biological nitrogen fixation (BNF), is crucial for improving soil fertility and reducing the need for synthetic nitrogen fertilizers.

Nano DAP formulation contains Nitrogen (8.0% N w/v) and Phosphorus (16.0% P₂O₅ w/v). Nano DAP (Liquid) has advantage in terms of surface area to volume as its particle size is less than 100 nanometres (nm). This unique property enables it to enter easily inside the seed surface or through stomata and other plant openings.

Using nano fertilizer topically leads to higher nutrient use efficiency (NUE) and a quicker reaction to plant growth. Because of their high reactivity and ease of penetration through the leaf cuticle, nano fertilizers provide controlled release and precise dispersion [10].

Materials and Methods

The experiment was conducted entitled "Response of nano dap on growth, yield and economics of cowpea (*Vigna unguiculata* L.)" during the summer season of 2024 at Cotton Research Station, Junagadh Agricultural University, Junagadh (21.5°N latitude and 70.5°E longitude with an altitude of 60 m above mean sea level) located in the South Saurashtra Agro-climatic Zone of Gujarat. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction with pH 8.08 and EC 0.33 dS/m. The soil was medium in available nitrogen (282.34 kg/ha), available phosphorus (42.65 kg/ha) and in available potash (278.11 kg/ha). The experiment was laid out in a randomized block design with three replications. The experiment comprised 10 treatments in combination of soil application, seed treatment and foliar application with conventional fertilizer and nano DAP viz., T₁ (Absolute control), T₂ (100% RDF (20-40-00 N-P₂O₅-K₂O kg/ha)), T₃ (75% RDF + seed treatment with nano DAP at 5 ml/kg seed),

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T₄ (50% RDF + seed treatment with nano DAP at 5 ml/kg seed), T₅ (T₃ + foliar spray of nano DAP at 2 ml/lit at 30 DAS), T₆ (T₃ + foliar spray of nano DAP at 4 ml/lit at 30 DAS) T₇ (75% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS and 40 DAS), T₈ (50% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS and 40 DAS), T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS) and T₁₀ (50% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS, 40 DAS and 50 DAS). The cowpea (*cv.* Gujarat Cowpea-6) was sown on 21st February 2024 at a spacing of 45 x 15 cm using seed rate of 25 kg/ha with RDF (20-40-00 N-P₂O₅-K₂O kg/ha) applied as basal.

Results and Discussion

Growth parameters

Highest plant height (52.50 cm) at 60 DAS and number of branches per plant (7.33) at harvest were found with application of treatment T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS). The increased plant height and number of branches may have resulted due to combined use of conventional DAP along with nano DAP as a seed treatment and foliar spray during the early vegetative stage, which enhanced crop growth. This will improve nutrient absorption through the stomata, leading to increased photosynthesis and enzymatic activity in the leaves. As a result, nano nitrogen is converted into proteins, amino acids, and growth hormones, which promote cell growth and could contribute to improved plant height and number of branches. Lowest plant height and number of branches were observed with treatment T₁ (Absolute Control). Illustrated in table 1. These results are in conformity with the findings of [5] [6] [13] [15] [1] [9] [16] [17] and [7].

The notable increase in dry matter accumulation per plant (27.43 g) by treatment T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS) can be attributed to the positive effects of nano fertilizers on plant height, number of branches and root nodules all contribute to greater dry matter accumulation. This increase is largely driven by photosynthesis, which transforms sunlight, CO₂ and water into glucose and other key compounds that boost overall biomass. Lowest dry matter accumulation recorded by treatment T₁ (Absolute Control). Depicted in table 1. These findings are in close agreement with the results obtained by [5] [6] [1] [9] [16].

Highest number of root nodules per plant (25.19) at 40 DAS and dry weight of root nodules per plant (376.42 mg) was recorded with application of treatment T₂ (100% RDF). The enhanced nodulation observed can be attributed to the application of nano DAP as both seed treatment and a foliar spray during the early growth stages of cowpea. This treatment boosts phosphorus availability, which in turn stimulates root development and overall plant growth, encourages nodule formation, and improves the efficiency of the rhizobium-legume symbiosis. Phosphorus plays a crucial role in cell nuclei and root tips, supporting cell division and root elongation, which leads to an increase in both the number and size of nodules. Lowest number of root nodules and dry weight of root nodules were observed under treatment T₁ (Absolute Control). Furnished in table 1. Similar reports were given by [6] and [7].

Yield attributes and Yield

Highest number of pods per plant (38.60), Length of pod (15.93 cm) and number of seed per pod (12.95) were recorded under the treatment T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS).

The foliar application of nano DAP improved nutrient availability and extended the photosynthetic period, increasing leaf area and delaying senescence, which boosted dry matter production. This led to better translocation of photosynthates from leaves to pods enhancing the number of pods per plant. Lowest yield attributes were observed under the treatment T₁ (Absolute Control). Illustrated in table 2. Similar finding was reported by [6] [14] [17] [16] [1] [9] and [17].

According to results treatment T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS) recorded highest yield attributes *viz.*, seed yield (1341 kg/ha), stover yield (2660 kg/ha) and biological yield (4001 kg/ha). The utilization of nano-scale nitrogen and phosphorus offered a notable advantage over conventional urea and DAP due to its reduced particle size, which increased the surface area for interaction and improved nutrient absorption efficiency. This enhanced absorption capability resulted in higher seed yield. This may be also resulted due to enhanced absorption capability have improved photosynthesis, dry matter accumulation and better translocation of photosynthates which has positive influence on overall yield and yield attributes. Lowest yield attributes were observed with treatment T₁ (Absolute Control). Shown in Table 2. The results of present investigation strongly support the findings of [4] [6] [7] [12] [13] [15] [1] [9] [16] [17] and [7].

The data Shown in Table 2 unveiled that employment of different treatments in this experiment did not exert any significant effect on harvest index (%) of cowpea.

Economics

The increased gross return (105894 ₹/ha) and net return (65030 ₹/ha) could be explained on the basis of increased seed and stover yield under the treatment T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS) which were highest among rest of the treatments. Lowest gross and net returns were recorded with application of treatment T₁ (Absolute Control). Furnished in Table 3. These results are in close proximity with the findings of [6] [1] [16] and [7].

A substantially higher net return (65030 ₹/ha) found with T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS) due to higher seed and stover yield was observed compare to rest of the treatments. Shown in table 3. These findings are in the line with those reported by [6] [1] [16] and [7].

Highest B: C ratio of 2.59 in T₉ (75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS) found due to high seed and stover yield compare to rest of the treatments. And lowest B: C ratio of 1.94 was observed with application of treatment T₁ (Absolute Control). Furnished in Table 3. The results of the present investigation strongly support the findings of [8] [14] [16] [1] and [7].

Future scope of the study

At present, synthetic fertilizer is applied through the soil to meet all of the nutrient needs of crops. This is extremely detrimental to the soil because of its aftereffects, and chemical leaching degrades the quality of surface water. This can be reduced by applying a portion of the required nutrients through foliar fertilizer, such as nano fertilizer, which has a higher capacity to get absorbed through the leaf surface. The effectiveness of nano fertilizer can be studied with other crops that are important to agriculture because foliar spraying fertilizer can even help quickly correct any nutrient deficiencies that may be present at any stage of growth.

Table 1: Effect of different treatments on the growth parameters of cowpea

Treatments	Plant height (cm)	Dry matter per plant (g)	Number of branches per plant	Number of root nodules per plant	Dry weight of root nodules per plant (mg)	
T ₁	Absolute control	37.63	18.92	4.13	18.67	192.33
T ₂	100% RDF (20:40:00 kg N-P ₂ O ₅ -K ₂ O /ha)	49.67	26.97	6.87	25.19	376.42
T ₃	75% RDF + seed treatment with nano DAP at 5 ml/kg seed	45.50	22.73	5.40	22.00	274.00
T ₄	50% RDF + seed treatment with nano DAP at 5 ml/kg seed	43.26	20.90	4.67	20.33	220.00
T ₅	T ₃ + foliar spray of nano DAP at 2 ml/lit at 30 DAS	46.03	24.13	5.97	24.43	359.41
T ₆	T ₃ + foliar spray of nano DAP at 4 ml/lit at 30 DAS	46.07	24.27	6.17	25.07	371.67
T ₇	75% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS and 40 DAS	50.67	27.15	7.08	22.33	333.88
T ₈	50% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS, 40 DAS and 50 DAS	45.22	22.57	5.04	21.56	246.67
T ₉	75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS	52.50	27.43	7.33	22.50	345.94
T ₁₀	50% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS, 40 DAS and 50 DAS	45.93	23.30	5.59	21.92	252.45
	S.Em.±	2.15	1.04	0.28	1.04	14.70
	C.D. at 5%	6.38	3.09	0.84	3.09	43.68
	C.V.%	8.04	7.56	8.40	8.03	8.56

Table 2: Effect of different treatments on the yield attributes and yield of cowpea

Treatments	Number of pods per plant	Length of pod (cm)	Number of seeds per pod	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)	
T ₁	Absolute control	19.53	9.27	8.60	789	1608	2397	32.92
T ₂	100% RDF (20:40:00 kg N-P ₂ O ₅ -K ₂ O /ha)	35.62	14.69	11.89	1152	2289	3441	33.48
T ₃	75% RDF + seed treatment with nano DAP at 5 ml/kg seed	25.49	12.63	10.02	1035	2078	3113	33.25
T ₄	50% RDF + seed treatment with nano DAP at 5 ml/kg seed	22.45	10.33	9.18	840	1707	2547	32.98
T ₅	T ₃ + foliar spray of nano DAP at 2 ml/lit at 30 DAS	30.41	13.76	10.97	1101	2203	3304	33.32
T ₆	T ₃ + foliar spray of nano DAP at 4 ml/lit at 30 DAS	31.36	14.08	11.34	1148	2282	3430	33.47
T ₇	75% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS and 40 DAS	36.21	15.25	12.45	1246	2473	3719	33.50
T ₈	50% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS, 40 DAS and 50 DAS	24.62	11.51	9.72	972	1965	2937	33.10
T ₉	75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS	38.60	15.93	12.95	1341	2660	4001	33.52
T ₁₀	50% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS, 40 DAS and 50 DAS	27.76	13.24	10.59	1067	2148	3215	33.19
	S.Em.±	1.54	0.61	0.53	64.13	127.08	191.01	1.95
	C.D. at 5%	4.58	1.81	1.58	191	378	568	NS
	C.V.%	9.15	8.07	8.54	10.39	10.28	10.31	10.14

Table 3: Effect of different treatments on the economics of cowpea

Treatments	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net return (₹/ha)	B: C ratio	
T ₁	Absolute control	62390	32108	30282	1.94
T ₂	100% RDF (20:40:00 kg N-P ₂ O ₅ -K ₂ O /ha)	90978	35257	55721	2.58
T ₃	75% RDF + seed treatment with nano DAP at 5 ml/kg seed	81781	34746	47035	2.35
T ₄	50% RDF + seed treatment with nano DAP at 5 ml/kg seed	66414	34065	32349	1.95
T ₅	T ₃ + foliar spray of nano DAP at 2 ml/lit at 30 DAS	86982	36530	50452	2.38
T ₆	T ₃ + foliar spray of nano DAP at 4 ml/lit at 30 DAS	90664	37890	52774	2.39
T ₇	75% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS and 40 DAS	98397	38145	60252	2.58
T ₈	50% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS, 40 DAS and 50 DAS	76829	39248	37581	1.96
T ₉	75% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS	105894	40864	65030	2.59
T ₁₀	50% RDF + foliar spray of nano DAP at 4 ml/lit at 30 DAS, 40 DAS and 50 DAS	84321	43327	40994	1.95

Conclusion

Based on one year's experimentation, it seems quite logical to conclude that for getting higher seed yield and net realization from summer cowpea, crop should be fertilized with 75% RDF (20: 40: 00 kg N: P₂O₅: K₂O /ha) + foliar spray of nano DAP at 4 ml/lit at 30 DAS and 40 DAS under the medium black calcareous soil of South Saurashtra Agro-climatic Zone. This treatment was closely followed by 75% RDF + foliar spray of nano DAP at 2 ml/lit at 30 DAS and 40 DAS and 100% RDF.

Conflict of interest

Authors have declared that no conflict of interest interests exist in publishing this article.

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