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GROWTH, YIELD AND ECONOMICS OF PEARLMILLET (*PENNISETUM GLAUCUM* L.) TO THE COMBINED APPLICATION OF NITROGEN AND NANO DAP

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ABSTRACT

A field trial on "Growth, yield and economics of pearlmillet (*Pennisetum glaucum* L.) to the combined application of nitrogen and nano DAP" was explored during the *kharif* season of 2024, at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha, Gujarat, India. The trial was laid out in Randomized Block Design (RBD) with three replications consisting of nine treatments. The outcomes of the trial revealed that significantly the higher plant height at harvest (158.13 cm), number effective tillers per plant (2.67), length of earhead (23.87 cm), girth of earhead (9.96 cm), weight of earhead (29.95 g), grain yield (2868 kg/ha) and straw yield (6098 kg/ha) of pearlmillet were recorded in the treatment received 100% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS (T_2). However, all these observations remained statistically at par with the treatment received 100% RDF (T_1) (80:40:00 kg $N:P_2O_5:K_2O$/ha). Whereas, a significant effect of the combined application of nitrogen and nano DAP were not noticed on test weight and harvest index of the pearlmillet. With regards to the economics, the highest gross realization (` 113314/ha), net realization (` 64576/ha) and benefit-cost ratio (BCR) (2.32) of pearlmillet were attained in the treatment received 100% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS (T_2) and all these were closely followed by the treatment received 100% RDF (T_1).

Key words : Nitrogen, Nano DAP, Seed treatment, Foliar spray, Pearlmillet, Growth, Yield and Economics.

Introduction

Pearlmillet is a dual-purpose C_4 annual tillering diploid (2n=14), small-seeded caryopsis, belonging to the family *Gramineae* or *Poaceae* and sub-family *Panicoideae*. It is scientifically known as *Pennisetum glaucum* L., commonly known as cat tail, spiked or bulrush millet and popularly known as *bajra*. Pearlmillet is a vital rainfed cereal crop of arid and semi-arid regions, showing wide adaptability to diverse climatic conditions and soil types in India. Notably, it can deliver a dependable yield under marginal environments and at the same time responds to high management conditions (Thakor *et al*., 2018).

Pearlmillet is the world's sixth and India's fourth most prominent food grain crop after rice, wheat and maize. India is the largest single producer of the pearlmillet, both in terms of area (7.57 M ha) and production (11.43 MT) during 2022-23 (Anonymous, 2023). In India, the main producing states of pearlmillet are Rajasthan (46%), Maharashtra (19%), Gujarat (11%), Uttar Pradesh (8%) and Haryana (6%) (Divya *et al*., 2017). In Gujarat, 0.50 M ha area was under pearlmillet, with production of 1.29 MT during 2022-23 (Anonymous, 2023).

Pearlmillet is nutritionally higher to maize and rice and is recognized as a "high energy" cereal as its grains contain approximately 11 to 19% protein content, 3 to 4.6% fat, 2.7% minerals, higher amounts of carotene, riboflavin (Vitamin B_2) and niacin (Vitamin B_4) (Angel and Singh, 2023). Apart from that, they are an excellent source of dietary fibre (1.5 to 3%), phytochemicals, micronutrients, nutraceuticals and hence, nowadays they are rightly termed as "nutricereal" (Babar *et al.*, 2021).

Inadequate soil fertility and erratic rains are the major constraints limiting crop production in the arid and semi-arid regions of India. Nitrogen, a key limiting factor in crop production of different agro-ecosystems, is one of the essential primary mineral nutrients required by pearlmillet as it plays a vital role in the production of chlorophyll and amino acids, consequently exhibiting diverse growth and yield response to nitrogen application as it has the utmost impact on the vegetative growth of plants (Meena *et al.*, 2024). Phosphorus, another important primary nutrient, plays key roles in many plant processes such as energy metabolism, nucleic acid and membrane synthesis, photosynthesis, respiration, nitrogen fixation and enzyme regulation, while enhancing plant vigour, root growth and produce quality (Babar *et al.*, 2021). After nitrogen, phosphorus is the second major limiting nutrient among primary mineral nutrients, affecting nearly 40% of the world's arable soils and therefore known as the "bottleneck of world hunger" (Reddy *et al.*, 2022).

At present times, in order to get higher yields, farmers are applying higher doses of fertilizers, which is causing significant environmental problems. At the same time, the cost of chemical fertilizers has been continuously increasing, subsequently creating an economic burden on farmers. Furthermore, the rising prices of chemical fertilizers have compelled Indian farmers to adopt imbalanced nutrient application, resulting in reduced crop yields and declining soil health, thereby threatening future agricultural productivity and food security. At this critical juncture, there is an urgent need to develop sustainable nutrient management strategies that maintain crop production while protecting soil health and the environment. Therefore, to develop judicious nutrient management options, the application of nano-technology in fertilizers emerges as a promising and efficient alternative (Tiwari *et al.*, 2022). The newly developed nano-fertilizers by using nano-technology are smaller in size, with a large surface area, leading to an increase in absorption capacity and controlled-release kinetics to targeted sites (Saqib *et al.*, 2025). The nano-sized clusters of nitrogen and phosphorus in nano DAP (8% w/v of nitrogen and 16% w/v phosphorus) are functionalized with bio-polymers and other additives, allowing for improving dispersion and absorption within plant systems. This results in higher seed vigour, increased chlorophyll production, improved photosynthetic efficiency, better quality and yield of crops. Additionally, precise and targeted application of nano DAP ensures the nutritional requirements of crops by minimizing environmental impact (Anonymous, 1967). Therefore, it is important to explore the use of nano DAP as an alternative to chemical fertilizers that are used by farmers. Owing to their higher efficacy, improved productivity, lower input usage, lower cost and low environmental pollution could ultimately help the farmers to overcome the present-day problems by promoting more sustainable and productive agriculture (Patil *et al.*, 2024). Keeping in view of the above situations, the present trial was carried out to study "Growth, yield and economics of pearlmillet (*Pennisetum glaucum* L.) to the combined application of nitrogen and nano DAP".

Materials and Methods

A field trial was executed during the *kharif* season of 2024 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha, Gujarat, India and is geographically positioned at 24^0-19' North latitude and 72^0-19' East longitude with an altitude of 154.52 metres above the mean sea level. The soil of the experimental field was loamy sand in texture, low in organic carbon (0.23%) and available nitrogen (163.39 kg/ha), medium in available phosphorus (33.19 kg/ha) and potash (275.65 kg/ha), with soil pH 7.56 and EC 0.21 dS/m. The variety selected was Gujarat Hybrid Bajra 1129 (GHB-1129), were sown with a spacing of 45 cm × 10 cm. The recommended dose of fertilizer application was 80:40:00 kg $N:P_2O_5:K_2O$/ha (N was applied through DAP and urea and P_2O_5 was applied through DAP). Seed treatment and foliar spray were applied through nano DAP. The trial was laid out in Randomized Block Design (RBD) with three replications consisting of nine treatments namely; T_1: 100% RDF (80:40:00 kg $N:P_2O_5:K_2O$/ha), T_2: 100% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS, T_3: 100% RDN + 50% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS, T_4: 100% RDN + 25% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS, T_5: 100% RDN + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30

DAS and 50 DAS, T_6: 75% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS, T_7: 75% RDN + 50% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS, T_8: 75% RDN + 25% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS and T_9: 75% RDN + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS. Five representative plants were selected randomly from each experimental net plot area and tagged for observations. These plants were used for documenting all the biometric observations and the mean values obtained were analysed statistically, following the procedures proposed by Gomez and Gomez (1984).

Results and Discussion

Growth and yield of pearlmillet to the combined application of nitrogen and nano DAP

The mean data pertaining to plant height at harvest, number of effective tillers per plant, earhead length, earhead girth and earhead weight, grain yield and straw yield of pearlmillet were significantly affected by the combined application of nitrogen and nano DAP (Table 1). Whereas, a significant effect of the combined application of nitrogen and nano DAP were not noticed on test weight and harvest index of the pearlmillet (Table 1).

Among the various treatments evaluated, the application of 100% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS (T_2) resulted in significantly higher plant height at harvest (158.13 cm), number of effective tillers/plant (2.67), earhead length (23.87 cm), earhead girth (9.96 cm), earhead weight (29.95 g), grain yield (2868 kg/ha) and straw yield (6098 kg/ha) of pearlmillet as compared to other treatments. The per cent increase in grain and straw yield by T_2 over T_1 treatment was to the tune of 9.67 and 8.04%, respectively. However, all these results remained statistically at par with the application of 100% RDF (T_1) in all aspects. Whereas, numerically, the maximum test weight (10.02 g) and harvest index (31.95%) of pearlmillet were also observed with application of 100% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS (T_2) and was closely followed by application of 100% RDF (T_1) in both aspects.

The remarkable increase in the plant height of

Table 1 : Growth and yield of pearlmillet as influenced by the combined application of nitrogen and nano DAP.

Treatments	Plant height (cm) at harvest	Effective tillers (No./plant)	Earhead length (cm)	Earhead girth (cm)	Earhead weight (g)	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
T_1	149.07	2.40	21.77	9.51	28.39	9.93	2615	5644	31.69
T_2	158.13	2.67	23.87	9.96	29.95	10.02	2868	6098	31.95
T_3	140.47	2.33	20.70	8.85	26.37	9.80	2509	5422	31.64
T_4	131.60	1.93	19.87	8.57	24.17	9.68	2370	5192	31.37
T_5	126.33	1.60	18.73	8.13	21.20	9.12	2137	5030	29.85
T_6	135.87	2.27	20.23	8.81	25.34	9.79	2458	5362	31.52
T_7	124.07	1.87	19.60	8.39	23.01	9.49	2252	5177	30.34
T_8	120.13	1.67	19.43	8.26	22.36	9.34	2208	5083	30.30
T_9	118.07	1.53	18.57	8.01	20.48	9.01	2069	4991	29.39
S.Em. ±	5.52	0.09	0.87	0.36	1.06	0.47	113.54	219.13	1.43
C.D. at 5%	16.54	0.28	2.61	1.07	3.17	NS	340.39	656.95	NS

pearlmillet might be due to the positive effect of nitrogen on cell division and cell expansion, which resulted in the promotion of a large number and length of internodes. Simultaneously, results in a progressive increase in plant height. These fallouts are in line with the findings of Prasad *et al.* (2014), Kadam *et al.* (2019), Rakesh *et al.* (2021) and Gowd *et al.* (2023). Furthermore, the higher yield response might be due to the fact that increased supply of nitrogen led to higher nutrient availability and stimulated the various physiological processes together with biochemical processes in the crop, leading to improved crop growth and development. Influence of nitrogen nutrition on stimulation of meristematic cell activity and development of strong cell walls, resulting in stiffer straw and profuse tillering, thereby increasing the number of effective tillers per plant. These results are already in agreement with those reported by Arshewar *et al.* (2018), Patel *et al.* (2018), Kadam *et al.* (2019) and Rakesh *et al.* (2021). In addition, nitrogen facilitated the transition from somatic meristematic activity to reproductive meristematic activity, promoting the development of floral primordia and resulting in improved earhead length and girth. These findings are supported by Gojariya *et al.* (2021). Moreover, nitrogen application enhanced flower fertility and boosted the leaf area and its duration, thereby improving photosynthetic efficiency and ensuring greater production and translocation of assimilates from source to sink. Simultaneously, the increased nitrogen supply promoted rapid expansion of dark green foliage, leading to higher carbohydrate synthesis and biomass accumulation. The combined effect of improved assimilate production, efficient partitioning towards reproductive organs and enhanced vegetative growth ultimately resulted in higher earhead weight along with increased biomass production, thereby leading to higher grain and straw yield. These findings are corroborated by Thakor *et al.* (2018), Kadam *et al.* (2019), Reddy *et al.* (2020), Gojariya *et al.* (2021), Rakesh *et al.* (2021) and Malakar *et al.* (2022).

The improved growth of the pearlmillet might be attributed to the crucial role of phosphorus in various metabolic pathways and its structural presence in nucleic acids, coenzymes, phosphoproteins and phospholipids, which enhanced nutrient utilization through better root development and overall plant growth. Similar responses were reported by Singh and Chauhan (2021) and Reddy *et al.* (2022). Better nutrient availability through the application of phosphorus also enhanced soil microbial activity and nutrient utilization, resulting in an increased number of effective tillers per plant and improved crop performance. These trends are supported by Singh *et al.* (2019) and Gojariya *et al.* (2021). Furthermore, phosphorus played a key role in energy transfer and metabolic reactions, facilitated by enhanced nutrient supply, particularly during the flowering stage, which leads to increased earhead length and weight through better grain formation. Similar outcomes were observed by Gojariya *et al.* (2021) and Reddy *et al.* (2022). Enhanced metabolic activity, photosynthesis and efficient translocation of photosynthates to sink organs improved yield attributes and biomass accumulation. Simultaneously, the role of phosphorus as an energy carrier supported vital physiological processes and vegetative growth, thereby increasing straw production. The combined improvement in growth, yield attributes and biomass ultimately led to higher grain and straw yield. These findings are corroborated by Pandey *et al.* (2018), Singh *et al.* (2019), Singh and Chauhan (2021), Reddy *et al.* (2022) and Angel and Singh (2023).

The increased plant height of pearlmillet might be associated with the application of nano DAP, which enhances the absorption and penetration of nano-nitrogen and phosphorus through the stomata of leaves due to its high surface area, reactivity, permeability and small size. This stimulates enzyme activity, protein synthesis and auxin metabolism, promoting cell division and elongation, thereby increasing plant height. These results are in conformity with the results findings by Prakash *et al.* (2023) in soybean, Attri (2023) in fine rice, Gurjar (2023) in black gram, Rajanikanthreddy *et al.* (2024) in sunflower, Khemshetty *et al.* (2024) in chickpea, Rajeshwari *et al.* (2024) in chilli, Sachin *et al.* (2024) in pigeonpea and Saqib *et al.* (2025) in wheat. Higher yield response might be due to improved availability and uptake of nano-nitrogen and phosphorus, where improved nitrogen uptake facilitated carbohydrate production and promoted healthy tiller bud growth, while improved phosphorus uptake facilitated efficient translocation of photosynthates to the developing tiller buds, which in turn supported their growth. The combined and synergistic effect of nitrogen and phosphorus nutrition ultimately increased the number of effective tillers while reducing the formation of barren tillers. These results are supported by studies of Thakur (2022) in rice and Saqib *et al.* (2025) in wheat. In addition, nano DAP application enhanced plant metabolic processes, gene expression, protein synthesis and photosynthetic activity, which promoted cell division and elongation of floral primordia, eventually resulting in higher earhead length and girth. Similar findings were reported by Poudel *et al.* (2023) in wheat, Khati (2023) in finger millet and Balachandrakumar *et al.* (2024) in cowpea. The enhanced photosynthetic activity increased assimilate

Table 2 : Economics of pearlmillet as influenced by the combined application of nitrogen and nano DAP.

Treatments	Gross realization (` /ha)	Cost of cultivation (` /ha)	Net realization (` /ha)	BCR
T_1	103990	45308	58682	2.30
T_2	113314	48738	64576	2.32
T_3	99829	48173	51656	2.07
T_4	94861	47605	47256	1.99
T_5	88323	47051	41272	1.88
T_6	98201	48468	49733	2.03
T_7	92086	47900	44186	1.92
T_8	90344	47333	43011	1.91
T_9	86505	46778	39727	1.85

Selling price of grain: ` 22.5/kg and straw: ` 8/kg.

production and efficient translocation and supported better weight of earhead as well as other yield attributes, thereby contributing to higher grain yield. These outcomes are in conformity with the findings of Thakur (2022) in rice, Prakash *et al*. (2023) in soybean, Khemshetty *et al*. (2024) in chickpea, Rajeshwari *et al*. (2024) in chilli, Patil *et al*. (2024) in pearlmillet and Saqib *et al*. (2025) in wheat. Furthermore, foliar spraying of nano DAP improved nitrogen and phosphorus availability, thereby advancing the nutrient uptake. Phosphorus absorption promoted better root development, while nitrogen absorption boosted vegetative growth. This synergistic effect increased the photosynthetic rate and biomass accumulation, ultimately driving overall crop growth as well as development and leading to the production of the maximum straw yield. These fallouts are in accordance with the findings of Prakash *et al*. (2023) in soybean and Patil *et al*. (2024) in pearlmillet.

Economics of pearlmillet to the combined application of nitrogen and nano DAP

The details of gross realization, total cost of cultivation, net realization and benefit-cost ratio (BCR) of pearlmillet as influenced by the combined application of nitrogen and nano DAP were worked out and presented in Table 2.

A perusal of data showed that the maximum gross realization, net realization and BCR (` 113314/ha, ` 64576/ha and 2.32, respectively) of pearlmillet was ensued with the application of 100% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 DAS and 50 DAS (T_2) and was followed by application of 100% RDF (T_1) (` 103990/ha, ` 58682/ha and 2.30, respectively).

Conclusion

Based on the findings of one year study, it can be concluded that either application of 100% RDN + 75% RDP through DAP + seed treatment with nano DAP (5 ml/kg seed) + foliar spray with nano DAP @ 5 ml/L at 30 and 50 DAS or application of 100% RDF (80:40:00 kg $N:P_2O_5:K_2O$/ha) proved to be an effective nutrient management practice for enhancing growth, yield and economics of pearlmillet during the *kharif* season grown in loamy sand under North Gujarat conditions.

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References

Angel, N.S. and Singh R. (2023). Response of bio-fertilizers and phosphorus on yield and economics of pearlmillet (*Pennisetum glaucum* L.). *Int. J. Environ. Clim. Change*, **13(7)**, 68-74.

Anonymous (1967). Ministry of Co-operation. Report on nano fertilizers, Government of India. Available at https://www.iffco.in/en/corporate/> accessed on 5th July, 2025.

Anonymous (2023). Ministry of Agriculture and Farmers Welfare, Department of Agriculture and Farmers Welfare. Report on economics, statistics and evaluation division, Government of India. *Agricultural statistics at a glance*, 1-451.

Arshewar, S.P., Karanjikar P.N., Dambale A.S. and Kawde M.B. (2018). Effect of nitrogen and zinc levels on growth, yield and economics of pearlmillet (*Pennisetum glaucum* L.). *Int. J. Bio-resource and Stress Manage.*, **9(6)**, 729-732.

Attri, M. (2023). Effect of nano urea and nano DAP on growth, yield and quality of fine rice (*cv*. Pusa basmati-1121). *Ph.D. Thesis*. Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu, India.

Babar, S.R., Athoni B.K. and Basamma K. (2021). Influence of nutrient levels on pearlmillet (*Pennisetum glaucum* L.) growth, yield and economics under dryland condition of northern Karnataka. *J. Pharmacog. Phytochem.*, **10(1)**, 333-336.

Balachandrakumar, V., Sowmiya K., Shofiya M., Gopika K. and Nithika M. (2024). Impact of nano DAP and Zn EDTA on cowpea growth and yield. *Int. J. Plant Soil Sci.*, **36(6)**, 317-326.

Divya, G., Vani K.P., Babu P.S. and Devi K.S. (2017). Impact of cultivars and integrated nutrient management on growth, yield and economics of summer pearl millet. *Int. J. Appl. Pure Sci. Agricult.*, **3(7)**, 2394-5532.

Gojariya, M.C., Desai N.H., Rabari K.V. and Chaudhary P.P. (2021). Effect of nitrogen and phosphorus levels on yield and quality of summer pearlmillet. *J. Pharmacog. Phytochem.*, **10(1)**, 1050-1052.

Gomez, K.A. and Gomez A.A. (1984). *Statistical procedures for agricultural research*, edition 2, John Wiley and Sons, inc., U. K., pp.139-153.

Gowd, K.A.K., Kumar S., Sharma J. and Sravankumar L. (2023). Effect of nitrogen and phosphorus levels on growth and yield of pearlmillet (*Pennisetum glaucum* L.). *The Pharma Innov. J.*, **12(9)**, 1971-1973.

Gurjar, T. (2023). Effect of Efficient Phosphorus Management on Black Gram (*Vigna mungo* L.). *M.Sc. (Agri.) Thesis*. Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.

Kadam, S.B., Pawar S.B. and Jakkawad S.R. (2019). Response of pearlmillet (*Pennisetum glaucum* L.) to levels and scheduling of nitrogen under Maharashtra condition. *J. Pharmacog. Phytochem.*, **8(3)**, 2922-2925.

Khati, V. (2023). Optimization of nano-DAP fertilization for improvement in growth, yield and seed quality of finger millet *(Eleusine coracana* L.). *M.Sc. (Agri.) Thesis*. Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal Uttarakhand, India.

Khemshetty, A., Patil D.H., Rathod P.S., Patil A.S. and Basavaraj K. (2024). Studies on nano DAP on growth, yield and quality of chickpeas under rainfed conditions of northeastern dry zone of Karnataka. *J. Exp. Agricult. Int.*, **46(3)**, 139-145.

Malakar, P., Gupta M., Gupta V., Thakur N.P., Mali N.L. and Anju K. (2022). Effect of cultivars and fertility levels on yield and economics of pearlmillet under rainfed condition of Jammu region. *The Pharma Innov. J.*, **11(4)**, 1054-1059.

Meena, K.R., Sharma O.P., Dhaker D.L., Sain R.S., Yadav A. and Bhamboo K. (2024). Effect of nitrogen levels and foliar application of nano-urea on productivity of pearlmillet (*Pennisetum glaucum* L.). *Int. J. Res. Agron.*, **7(10)**, 255-258.

Pandey, M., Abidi A.B. and Singh R.P. (2018). Effect of sulphur and phosphorus on yield and quality of pearlmillet (*Pennisetum glaucum* L.). *Annals of Plant and Soil Research*, **20(3)**, 272-275.

Patel, S.A., Chaudhary P.P., Chaudhary N. and Chaudhary H.L. (2018). Effect of wheat residue management and fertilizer levels on growth, yield attributes and yield of summer pearlmillet (*Pennisetum glaucum* L.) under north Gujarat condition. *J. Pharmacog. Phytochem.*, **7(6)**, 1292-1295.

Patil, M., Ravi S., Veeresh H., Ashok Kumar Gaddi and Krishnamurthy D. (2024). Response of pearlmillet (*Pennisetum glaucum* L.) to foliar spray of nano DAP. *Int. J. Res. Agron.*, **7(10)**, 995-999.

Poudel, A., Singh S.K., Jiménez-Ballesta R., Jatav S.S., Patra A. and Pandey A. (2023). Effect of nano-phosphorus formulation on growth, yield and nutritional quality of wheat under semi-arid climate. *Agronomy*, **13(3)**, 768.

Prakash, A.N., Siddaram R. and Bellakki M.A. (2023). Response of nano DAP on growth, yield and economics of soybean (*Glycine max* L.). *The Pharma Innov.*, **12(12)**, 1985-1989.

Prasad, S.K., Singh M.K. and Singh R. (2014). Effect of nitrogen and zinc fertilizer on pearlmillet (*Pennisetum glaucum*) under agri-horti system of eastern Uttar Pradesh. *The Bioscan*, **9(1)**, 163-166.

Rajanikanthreddy, Ganigara B.S., Shakuntala N.M., Hiremath U., Satihal D., Kulkarni S and Nivedita (2024). Effect of seed treatment and foliar spray of nano DAP on plant growth and seed yield in RSFH-700 sunflower hybrid seed production. *Int. J. Res. Agron.*, **7(11)**, 292-295.

Rajeshwari, N., Mavarkar S. and Ravi C.S. (2024). Effect of nano DAP and urea on growth, yield and quality of chilli (*Capsicum annuum* L.). *Ecol., Environ. Conser. (0971765X)*, **7**.

Rakesh, K., Umesha C. and Balachandra Y. (2021). Influence of nitrogen and zinc levels on pearlmillet (*Pennisetum glaucum* L.). *Biological Forum–An Int. J.*, **13(1)**, 128-132.

Reddy, S.B.P., Madhuri K.N., Venkaiah K. and Prathima T. (2020). Influence of nitrogen and potassium application on yield and nutrient uptake in pearlmillet. *Andhra Pradesh J. Agricult. Sci.*, **6(4)**, 166-173.

Reddy, V.S.N., Singh R. and Deepika C.L. (2022). Effect of phosphorus and zinc on growth and yield of pearlmillet (*Pennisetum glaucum* L.). *The Pharma Innov. J.*, **11(4)**, 542-5.

Sachin, R., Patil S., Yadahalli G., Nandagavi R. and Vidyavathi G. (2024). Assessing the growth and yield responses of rainfed pigeonpea (*Cajanus cajan* (L.) Millsp.) to nano-DAP fertilizer application. *J. Farm Sci.*, **37(02)**, 129-136.

Saqib, A., Manuja S., Kumar N., Sharma R.P., Kumar A., Thakur D., Kumari S., Mujahed B.A. and Anshumali (2025). Effect of nano DAP seed treatment and foliar spray on growth, yield attributes and yield of wheat (*Triticum aestivum* L.). *Int. J. Res. Agron.*, **8(3)**, 119-123.

Singh, S. and Chauhan T.M. (2021). Effect of phosphorus and FYM on yield and uptake of nutrients in pearlmillet. *Indian J. Agricult. Sci.*, **91(5)**, 753-6.

Singh, S., Singh V., Shukla R.D. and Yadav B. (2019). Effect of planting geometry and phosphorus levels on pearlmillet (*Pennisetum glaucum* L.). *Progressive Res.-An Int. J.*, **14(1)**, 18-22.

Thakor, K.P., Usadadia V.P., Savani N.G., Arvadiya L.K. and Patel P.B. (2018). Effect of irrigation schedule and nitrogen management on productivity, profitability of summer pearlmillet grown under clay soils of south Gujarat. *Int. J. Agricult. Innov. Res.*, **6(4)**, 10-11.

Thakur, A. (2022). Effect of nano DAP on rice yield and chemical properties of soil. *M.Sc. (Agri.) Thesis.* Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India.

Tiwari, K.N., Kumar Y., Singh T. and Nayak R. (2022). Nano technology-based P fertilizers for higher efficiency and agriculture sustainability. *Annals of Plant and Soil Research*, **24(2)**, 198-207.