

Summary of Nano Urea Trial Details (Rabi 2019-20 to Rabi 2022-23)

SN	Crop	Trial (No.)	Yield Increase (%)	Nitrogen Saving or Reduction (%)	Trial Locations & Season
	Cereals				
1	Paddy	21	Upto 24.4%	25-50%	ICAR-CSSRI, Karnal (<i>Kharif 2021 & 2022</i>); IRRI-ISARC, Varanasi (<i>Kharif 2021- 3 Trials</i>); ICAR-CIARI, Port Blair (<i>Rabi 2021-22</i>); ICAR-CIARI, Andaman (KVK Guptapara)- <i>Rabi 2021-22</i> ; ICAR-CIARI, Andaman (KVK Nimbudera)- <i>Rabi 2021-22</i> ; ICAR-AICRPDA Centre, Jagdalpur, Chattisgarh (<i>Kharif 2021</i>); TNAU, Coimbatore (<i>Summer 2021 & 2022</i>); SKUAST, Jammu (<i>Kharif 2021</i>); UAS GKVK, Karnataka (<i>Summer 2019-20; Kharif 2020 & 2021</i>); UAHS, Shivamoga (<i>Rabi 2019-20</i>); AAU, Jorhat (<i>Kharif 2020, 2021 & 2022</i>); ANDUAT, Kumarganj, Ayodhya (<i>Kharif 2020 & 2021</i>)
2	Wheat	17 (3 Pooled)	Upto 23.1%	25-50%	AAU, Gujarat (<i>Rabi 2019-20 & 2020-21- Pooled</i>); MPUAT, Udaipur (<i>Rabi 2019-20 & 2020-21- Pooled</i>); SKNAU, Jobner (<i>Rabi 2019-20 & 2020-21- Pooled & Rabi 2021-22</i>); ICAR-CSSRI, Karnal (<i>2020-21 & 2021-22</i>); ICAR-IARI, New Delhi (<i>Rabi 2019-20 & 2020-21</i>), ANDUAT, UP (<i>Rabi 2019-20</i>); BAU, Ranchi (<i>2019-20, 2020-21 & 2021-22</i>); SKUAST, Jammu (<i>Rabi 2021-22</i>), CSAUAT, Kanpur, UP (<i>Rabi 2019-20: 2 Trials & Rabi 2020-21: 1 Trial</i>), BUAT, Banda, UP (<i>Rabi 2019-20</i>)
3	Maize	14 (1 Pooled)	Upto 40.7%	25-50%	AAU, Gujarat (<i>Kharif 2020 & 2021- Pooled</i>); ICAR-CRIDA, Hyderabad (<i>Kharif 2021</i>); UAS, Raichur (<i>Rabi 2019-20 & Kharif 2020</i>); UAS GKVK, Karnataka (<i>Summer 2020; Kharif 2020 & 2021</i>); PJTSAU, Telangana (<i>Summer 2019-20</i>); MPUAT, Udaipur (<i>Kharif 2020</i>); GBPUAT, Pantanagar (<i>Summer 2021</i>), ICAR-IARI, New Delhi (<i>Kharif 2020 & 2021</i>), TNAU, Coimbatore (<i>Kharif 2021 & Summer 2022</i>)
	Millets				
4	Pearl Millet (Bajra)	3 (1 Pooled)	Upto 7.8%	25-50%	SKNAU, Jobner (<i>Kharif 2020 & 2021- Pooled</i>), ICAR-IARI, New Delhi (<i>Kharif 2020 & 2021</i>)
5	Finger Millet (Ragi)	1	10.8%	25%	AICRPDA Centre, Bengaluru (<i>Kharif 2021</i>)
6	Rabi Sorghum (Jowar)	1	At Par	25%	RARS-Vijayapura, Dharwad, Karnataka (ICAR-CRIDA, Hyderabad)- <i>Rabi 2021-22</i>
	Oilseed				
7	Mustard	5	Upto 13.76%	25-50%	MPUAT, Udaipur (<i>Rabi 2021-22</i>); SKNAU, Jobner (<i>Rabi 2020-21 & 2021-22</i>), ICAR-IARI, New Delhi (<i>Rabi 2020-21 & 2021-22</i>)
8	Castor	1	6.1%	25%	JAU, Gujarat (<i>Kharif 2021</i>)
	Pulses				
9	Frenchbean/ Rajma	1	3.9%	50%	CSAUAT, Kanpur (<i>Rabi 2020-21</i>)
	Cash Crops				
10	Sugarcane	1 (Pooled)	3.6%	50%	MPKV, Rahuri (<i>Rabi 2020-21, 2021-22 & 2022-23- Pooled</i>)
11	Cotton	2	1.3-28.6%	50%	UAS, Raichur (<i>Kharif 2020 & 2021</i>)
12	Tea	2	2.6-5%	25-50%	TRA, Assam (<i>2022 & 2023</i>)
	Vegetables				
13	Tomato	5	3.1-5.4%	50%	ICAR-IIHR, Bengaluru (<i>Rabi 2019-20</i>); UAHS, Shivamoga (<i>Rabi 2019-20</i>), MPKV, Rahuri (<i>Summer 2020 & 2021</i>), CSAUAT, Kanpur, UP (<i>Rabi 2020-21</i>)
14	Cabbage	2	3.4-20.2%	50%	ICAR-IIHR, Bengaluru (<i>Rabi 2019-20</i>); UAHS, Shivamoga (<i>Rabi 2019-20</i>)
15	Onion	2	1.7-3.3%	50%	MPKV, Rahuri (<i>Rabi 2019-20 & 2020-21</i>)
16	Cucumber	1	5.50%	50%	ICAR-IIHR, Bengaluru (<i>Rabi 2019-20</i>)
	Spices				
17	Ginger (Fresh)	1 (Pooled)	34-62.3%	50%	ICAR-IISR, Kozikode, Kerala (<i>2021-22 & 2022-23</i>)
	Total	80			

Multi location- Multi Crop-Agro Climatic Zone Wise Nano Urea Trials

SN	ACZ	State	Location	Crops	Season	Treatments	N Dose	Urea Qty	Grain Yield *	%Inc over	Urea reduction/ha
							(Kg)	(Kg/ha)	(Kg/ha)	RDF	(45 Kg bag)
1	Western Himalayan Region (i)	Jammu & Kashmir	SKUAST, Jammu	Paddy	Kharif 2021	RDF (50:25:15:20 NPKZn Kg /ha)	50	109	4177	-	-
						RDF with 25% N reduction & 2 Sprays of Nano N @2ml/ L	37.5	82	4207	At Par	0.6
						RDF with 50% N reduction & 2 Sprays of Nano N @2ml/ L	25	54	4192	At Par	1.21
2	Western Himalayan Region (i)	Jammu & Kashmir	SKUAST, Jammu	Wheat	Rabi 2021-22	RDF (100:50:25:20 NPKZn Kg /ha)	100	217	4608	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N @2ml/ L	50	109	4858	5.4	2.42
						RDF with 25% N reduction & 2 Sprays of Nano N @2ml/ L	75	163	4915	6.7	1.21
3	Eastern Himalayan Zone (ii)	Assam	AAU, Jorhat, Assam	Paddy	Kharif 2020	RDF (60:20:40 NPK Kg/ ha)	60	130	4260	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @ 4 ml /L	30	65	5300	24.4	1.45
4	Eastern Himalayan Zone (ii)	Assam	AAU, Jorhat, Assam	Paddy	Kharif 2021	RDF (60:20:40 NPK Kg/ ha)	60	130	2913	-	-
						RDF with 33 % N reduction & 2 Sprays of Nano N @ 4 ml / litre	40	87	3147	8	0.97
5	Eastern Himalayan Zone (ii)	Assam	AAU, Jorhat, Assam	Paddy	Kharif 2022	RDF (60:20:40 NPK Kg/ ha)	60	130	4300	-	-
						RDF with 33 % N reduction & 2 Sprays of Nano N @ 4 ml / litre	40	87	4310	At Par	0.97
6	Eastern Himalayan Region (ii)	Assam	Tea Research Association (TRA), Tocklai, Assam	Tea	2022	RDF (100:25:100 NPK Kg/ ha)	100	218	2068	-	-
						RDF with 25 % N reduction & 4 Sprays of Nano N	75	164	2163	4.6	1.21
						RDF with 50 % N reduction & 6 Sprays of Nano N	50	109	2122	2.6	2.42
7	Eastern Himalayan Region (ii)	Assam	Tea Research Association (TRA), Tocklai, Assam	Tea	2023	RDF (100:25:100 NPK Kg/ ha)	100	218	2109	-	-
						RDF with 25 % N reduction & 4 Sprays of Nano N	75	164	2214	5	1.21
						RDF with 50 % N reduction & 6 Sprays of Nano N	50	109	2170	2.9	2.42
8	Middle Gangetic Plain Region (iv)	Uttar Pradesh	ANDUAT, Kumarganj, Ayodhya	Wheat	Rabi 2019-20	RDF (150:80:60 NPK Kg /ha)	150	326	3200	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	75	163	3940	23.1	3.62
9	Middle Gangetic Plain Region (iv)	Uttar Pradesh	ANDUAT, Kumarganj, Ayodhya	Paddy	Kharif 2020	RDF (120:60:40 NPK Kg/ ha)	120	260	6160	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	60	130	6220	1	2.9
10	Middle Gangetic Plain Region (iv)	Uttar Pradesh	IRRI-ISARC, Varanasi	Irrigated Rice	Kharif 2021	RDF (120: 60:40 Kg/ ha)	120	261	7600	-	-
						RDN with 34 % N reduction & 1 Spray of Nano Urea @ 4ml / litre at PI stage	79.2	172	7900	3.9	1.97
11	Middle Gangetic Plain Region (iv)	Uttar Pradesh	IRRI-ISARC, Varanasi	Rainfed Rice	Kharif 2021	RDF (80: 60:40 Kg/ ha)	80	174	4400	-	-
						RDN with 34 % N reduction & 2 Spray of Nano Urea @ 2ml / litre at MT and at PI stage	52.8	115	4900	11.4	1.31
12	Middle Gangetic Plain Region (iv)	Uttar Pradesh	IRRI-ISARC, Varanasi	Rainfed Rice	Kharif 2021	RDF (60: 20:40 Kg/ ha)	60	130	4000	-	-
						RDN with 34 % N reduction & 2 Spray of Nano Urea @ 2ml / litre at MT and at PI stage	39.6	86	4400	10	0.99
13	Middle Gangetic Plain Region (iv)	Uttar Pradesh	ANDUAT, Kumarganj, Ayodhya	Paddy	Kharif 2021	RDF (120:60:40 NPK Kg/ ha)	120	260	6050	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	60	130	6180	2.1	2.9
14	Upper Gangetic Plain Region (v)	Uttar Pradesh	CSAUAT, Kanpur (University Research Farm/ Station)	Wheat	Rabi 2019-20	RDF (120:60:40 NPK Kg/ ha)	120	260	3080	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	60	130	3350	8.8	2.9
15	Upper Gangetic Plain Region (v)	Uttar Pradesh	CSAUAT, Kanpur (5 Farmers Field Trial)	Wheat	Rabi 2019-20	RDF (120:60:40 NPK Kg/ ha)	120	260	4440	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	60	130	4901	10.4	2.9
16	Upper Gangetic Plain Region (v)	Uttar Pradesh	CSAUAT, Kanpur	Wheat	Rabi 2020-21	RDF (120:60:40 NPK Kg/ ha)	120	260	1400	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	60	130	1480	5.7	2.9

17	Upper Gangetic Plain Region (v)	Uttar Pradesh	CSAUAT, Kanpur	Tomato	Rabi 2020-21	RDF (120:60:50 NPK Kg/ ha)	120	260	18000	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	60	130	18600	3.3	2.9
18	Upper Gangetic Plain Region (v)	Uttar Pradesh	CSAUAT, Kanpur	Onion	Rabi 2020-21	RDF (110:40:60 NPK Kg/ ha)	110	240	17200	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	55	120	17500	1.7	2.66
19	Upper Gangetic Plain Region (v)	Uttar Pradesh	CSAUAT, Kanpur	Frenchbean	Rabi 2020-21	RDF (100:60:60 NPK Kg/ ha)	100	218	7812	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	50	109	8114	3.9	2.42
20	Upper Gangetic Plain Region (v)	Uttarakhand	GBPUAT, Pantnagar, Uttarakhand	Maize	Summer 2021	RDF (120:60:40 NPK Kg/ ha)	120	260	6566	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @ 4 ml / litre & Nano Zn @2 ml/ litre	60	130	7353	12	2.9
21	Trans Gangetic Plain Regions (vi)	Haryana	ICAR-CSSRI Karnal, Haryana	Wheat	Rabi 2020-21	RDF (150 Kg N Kg /ha)	150	326	4574	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	75	163	4619	1	3.62
						RDF with 33% N reduction & 1 Spray of Nano N	100.5	218	4651	1.7	2.39
22	Trans Gangetic Plain Regions (vi)	Haryana	ICAR-CSSRI Karnal, Haryana	Paddy	Kharif 2021	RDF (90 Kg N Kg /ha)	90	196	4466	-	-
						RDF with 33% N reduction & 1 Spray of Nano N	60.3	131	4525	1.3	1.43
23	Trans Gangetic Plain Regions (vi)	Haryana	ICAR-CSSRI, Karnal, Haryana	Wheat	Rabi 2021-22	RDF (150 Kg N/ ha)	150	326	4183	-	-
						RDF with 33% N reduction & 1 Spray of Nano N @4ml/ Litre	100.5	218	4206	At Par	2.39
24	Trans Gangetic Plain Regions (vi)	Haryana	ICAR-CSSRI Karnal, Haryana	Paddy	Kharif 2022	RDF (90 Kg N Kg /ha)	90	196	3708	-	-
						RDF with 33% N reduction & 1 Spray of Nano N	60.3	131	3789	2.2	1.43
25	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Wheat	Rabi 2019-20	RDF (120:60:60 NPK Kg/ ha)	120	260	5020	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	60	130	4930	At Par	2.9
26	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Wheat	Rabi 2020-21	RDF (120:60:60 NPK Kg/ ha)	120	260	5140	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	60	130	4910	At Par	2.9
27	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Mustard	Rabi 2019-20	RDF (80:40:30 NPK Kg/ ha)	80	174	2280	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	60	130	2250	At Par	0.97
28	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Mustard	Rabi 2020-21	RDF (80:40:30 NPK Kg/ ha)	80	174	2310	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	60	130	2180	At Par	0.97
29	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Maize	Kharif 2020	RDF (150:75:75 NPK Kg/ ha)	150	326	5980	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	113	246	5930	At Par	1.79
30	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Maize	Kharif 2021	RDF (150:75:75 NPK Kg/ ha)	150	326	6010	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	113	246	5900	At Par	1.79
31	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Pearlmillet/ Bajra	Kharif 2020	RDF (60:60:30 NPK Kg/ ha)	60	130	3330	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	45	98	3290	At Par	0.72
32	Trans Gangetic Plain Regions (vi)	New Delhi	ICAR-IARI, PUSA, New Delhi	Pearlmillet/ Bajra	Kharif 2021	RDF (60:60:30 NPK Kg/ ha)	60	130	3350	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @4ml/ litre	45	98	3250	At Par	0.72
33	Eastern Plateau & Hills (vii)	Jharkhand	BAU, Ranchi	Wheat	Rabi 2019-20	RDF (150:60:40 NPK Kg /ha)	150	326	3430	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	75	163	4220	23	3.62
34	Eastern Plateau & Hills (vii)	Jharkhand	BAU, Ranchi	Wheat	Rabi 2020-21	RDF (150:60:40:25 NPKZn Kg /ha)	150	326	3491	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N @4ml/ Litre	75	163	4141	18.6	3.62
35	Eastern Plateau & Hills (vii)	Chhattisgarh	AICRPDA Centre, Jagdalpura, Chhattisgarh (ICAR-CRIDA Trial)	Upland Rice	Kharif 2021	RDF (80:40:40:10 NPKZn Kg /ha)	80	174	2910	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2ml / litre at 30-35 and 50-55 DAS	60	130	2970	2.1	0.97
						RDF with 25 % N reduction & 3 Sprays of Nano N @ 2ml / litre at 30-35, 50-55 DAS &	60	130	3265	12.2	0.97

36	Eastern Plateau & Hills (vii)	Jharkhand	BAU, Ranchi, Jharkhand	Wheat	Rabi 2021-22	RDF (150:60:40:25 NPKZn Kg /ha)	150	326	3916	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N @4ml/ Litre	75	163	4254	8.6	3.62
37	Central Plateau and Hills/ Vindya Plateau (viii)	Uttar Pradesh	BAUT, Banda (15 Farmers Field Trial)	Wheat	Rabi 2019-20	RDF (120:60:40 NPK Kg/ ha)	120	260	2591	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @4ml/ litre at 25-30 DAT & before flowering	60	130	3163	22.1	2.9
38	Western Plateau & Hills (ix)	Maharashtra	MPKV, Rahuri, Maharashtra	Sugarcane	2020-21 to 2022-23 (Pooled)-3 Yrs.	RDF (250:115:115 NPK Kg/ ha)	250	543	146500	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @ 4 ml / litre at 60 and 75 DAT	125	272	151800	3.6	6.04
39	Western Plateau & Hills (ix)	Maharashtra	MPKVV, Rahuri, Maharashtra	Onion	Rabi 2019-20	RDF (100:50:50 NPK Kg/ha)	100	217	34860	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	50	109	36000	3.3	2.42
40	Western Plateau & Hills (ix)	Maharashtra	MPKVV, Rahuri, Maharashtra	Tomato	Summer 2020	RDF (300:150:150 NPK Kg/ha)	300	652	60890	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N @4ml/ litre	150	326	63900	4.9	7.25
41	Western Plateau & Hills (ix)	Maharashtra	MPKVV, Rahuri, Maharashtra	Tomato	Summer 2021	RDF (300:150:150 NPK Kg/ha)	300	652	63000	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N @4ml/ litre	150	326	66400	5.4	7.25
42	Southern Plateau & Hills (x)	Karnataka	UAHS, Shivamoga, Karnataka	Paddy	Rabi 2019-20	RDF (100:62:62 NPK Kg /ha)	100	217	2775	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	50	109	3164	14	2.42
43	Southern Plateau & Hills (x)	Karnataka	UAHS, Shivamoga, Karnataka	Tomato	Rabi 2019-20	RDF (250:250:250 NPK Kg/ ha)	250	543	64660	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	125	272	72070	11.5	6.04
44	Southern Plateau & Hills (x)	Karnataka	UAHS, Shivamoga, Karnataka	Cabbage	Rabi 2019-20	RDF (150:100:125 NPK Kg/ ha)	150	326	44700	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	75	163	53740	20.2	3.62
45	Southern Plateau & Hills (x)	Karnataka	UAS, Raichur Karnataka	Maize	Rabi 2019-20	RDF (150:65:65 NPK Kg/ ha)	150	326	5077	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	75	163	5827	14.8	3.62
46	Southern Plateau & Hills (x)	Karnataka	UAS GKVK, Karnataka	Paddy	Summer 2020	RDF (100:50:50 NPK Kg/ ha)	100	217	6340	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	50	109	6370	At Par	2.42
47	Southern Plateau & Hills (x)	Karnataka	UAS GKVK, Karnataka	Maize	Summer 2020	RDF (150:75:40 NPK Kg /ha)	150	326	5747	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	75	163	6138	6.8	3.62
48	Southern Plateau & Hills (x)	Telangana	PJ TSAU, Telangana	Maize	Summer 2020	RDF (200:60:50 NPK Kg/ha)	176.5	384	6633	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	88.3	192	6750	1.8	4.26
49	Southern Plateau & Hills (x)	Karnataka	UAS GKVK, Karnataka	Paddy	Kharif 2020	RDF (100:50:50 NPK Kg/ ha)	100	217	5260	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	50	109	5420	3	2.42
50	Southern Plateau & Hills (x)	Karnataka	UAS GKVK, Karnataka	Maize	Kharif 2020	RDF (150:75:37.5 NPK Kg/ ha)	150	326	8310	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	75	163	9140	10	3.62
51	Southern Plateau & Hills (x)	Karnataka	UAS, Raichur Karnataka	Maize	Kharif 2020	RDF (150:65:65 NPK Kg/ ha)	150	326	4740	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	75	163	4937	4.2	3.62
52	Southern Plateau & Hills (x)	Karnataka	UAS, Raichur Karnataka	Cotton	Kharif 2020	RDF (150:68:90 NPK Kg/ ha)	150	326	1892	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	75	163	1916	1.3	3.62
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre & Sagarika Liquid @2ml/ litre	75	163	2434	28.6	3.62
53	Southern Plateau & Hills (x)	Karnataka	AICRPDA Centre, Bengaluru (ICAR-CRIDA Trial)	Fingermillet	Kharif 2021	RDF (50:40:37.5:12.5 NPKZn Kg /ha)	50	109	2742	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2ml / litre at 35 and 55 DAS	37.5	82	3038	10.8	0.6
54	Southern Plateau & Hills (x)	Karnataka	UAS GKVK, Karnataka	Paddy	Kharif 2021	RDF (100:50:50 NPK Kg/ ha)	100	217	5220	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	50	109	5260	At Par	2.42
55	Southern Plateau & Hills (x)	Karnataka	UAS GKVK, Karnataka	Maize	Kharif 2021	RDF (150:75:37.5 NPK Kg/ ha)	150	326	8210	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	75	163	8350	1.7	3.62
						RDF (150:68:90 NPK Kg/ ha)	150	326	1943	-	-

56	Southern Plateau & Hills (x)	Karnataka	UAS, Raichur Karnataka	Cotton	Kharif 2021	RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	75	163	1968	1.3	3.62
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre & Sagarika Liquid @2ml/ litre	75	163	2474	27.3	3.62
57	Southern Plateau & Hills (x)	Karnataka	RARS - Vijayapura, Dharwad, Karnataka (ICAR-CRIDA Trial)	Rabi Sorghum	Rabi 2021-22	RDF (50:25:0:10 NPKZn Kg/ ha)	50	109	1479	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2ml / litre at 25 and 45 DAS	37.5	82	1489	At Par	0.6
58	Southern Plateau & Hills (x)	Telangana	ICAR- CRIDA, Hyderabad, Telengana	Maize	Kharif 2021	RDF (90:45:45 NPK Kg/ha)	90	196	2694	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2ml / litre at 25 and 45 DAS	67.5	147	2801	4	1.09
59	Eastern Coastal Plains & Hills (xi)	Tamilnadu	TNAU, Coimbatore (Drone Sray)	Paddy	Summer 2021	RDF (150:50:50 NPK Kg /ha)	150	326	6030	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	75	163	6970	15.6	3.62
60	Eastern Coastal Plains & Hills (xi)	Tamilnadu	TNAU, Coimbatore (Drone Sray)	Maize	Kharif 2021	RDF (250:75:75 NPK Kg /ha)	250	544	5020	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	125	272	7065	40.7	6.04
61	Eastern Coastal Plains & Hills (xi)	Tamilnadu	TNAU, Coimbatore (Drone Sray)	Paddy	Summer 2022	RDF (150:50:50 NPK Kg /ha)	150	326	5454	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	75	163	5909	8.3	3.62
62	Eastern Coastal Plains & Hills (xi)	Tamilnadu	TNAU, Coimbatore (Drone Sray)	Maize	Summer 2022	RDF (250:75:75 NPK Kg /ha)	250	544	5474	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	125	272	6795	24.1	6.04
63	Western Coastal Plains & Ghat (xii)	Karnataka	ICAR-IIHR, Bengaluru, Karnataka	Cabbage	Rabi 2019-20	RDF (150:100:125 NPK Kg/ha)	150	326	56500	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	75	163	58400	3.4	3.62
64	Western Coastal Plains & Ghat (xii)	Karnataka	ICAR-IIHR, Bengaluru, Karnataka	Cucumber	Rabi 2019-20	RDF (113:75:113 NPK Kg/ha)	113	246	12000	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	56.5	123	12660	5.5	2.73
65	Western Coastal Plains & Ghat (xii)	Karnataka	ICAR-IIHR, Bengaluru, Karnataka	Tomato	Rabi 2019-20	RDF (180:120:150 NPK Kg/ ha)	180	391	86100	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	90	196	88800	3.1	4.35
66	Western Coastal Plains & Ghat (xii)	Kerala	ICAR-IISR, Kozhikode, Kerala	Ginger	Rabi 2021-22	RDF (120:55:80 NPK Kg/ ha)	120	260	16440	-	-
						RDF with 50% N reduction & 2 Spray of Nano N @4ml/ Litre	60	130	27440	67	2.9
67	Gujarat Plains & Hills (xiii)	Gujarat	AAU, Anand, Gujarat	Wheat	Rabi 2019-20 & 2020-21 (Pooled)- 2 Yrs.	RDF (120:60:0 NPK Kg /ha)	120	261	4712	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N	60	130	4940	4.8	2.9
68	Gujarat Plains & Hills (xiii)	Gujarat	AAU, Anand, Gujarat	Maize	Kharif 2020 & 2021 (Pooled)- 2 Yrs.	RDF (120:60:0 NPK Kg /ha)	120	261	5135	-	-
						RDF with 50% N reduction & 2 Sprays of Nano N @4ml/ Litre	60	130	5214	1.5	2.9
69	Gujarat Plains & Hills (xiii)	Gujarat	JAU, Gujarat	Castor (Annual Crop)	Kharif 2021	RDF (120:50:50 NPK Kg /ha)	120	261	3158	-	-
						RDF with 25% N reduction & 3 Sprays of Nano N @2ml/ Litre	90	196	3351	6.1	1.45
70	Western Dry Region (xiv)	Rajasthan	MPUAT, Udaipur, Rajasthan	Wheat	Rabi 2019-20 & 2020-21 (Pooled)- 2 Yrs.	RDF (90:35:30 NPK Kg /ha)	90	196	4461	-	-
						RDF with 25% N reduction & 2 Sprays of Nano N	67.5	147	5370	20.3	1.09
71	Western Dry Region (xiv)	Rajasthan	SKNAU, Jobner, Rajasthan	Wheat	Rabi 2019-20 & 2020-21 (Pooled)- 2 Yrs.	RDF (120:40:30:20:5 NPKSZn Kg /ha)	120	261	4681	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2.5ml / litre at 35 and 55 DAS	90	196	5397	15.3	1.45
						RDF with 50 % N reduction & 2 Sprays of Nano N @ 2.5ml / litre at 35 and 55 DAS	60	130	4704	At Par	2.9
72	Western Dry Region (xiv)	Rajasthan	SKNAU, Jobner, Rajasthan	Pearl Millet (Bajra)	Kharif 2020 & 2021 (Pooled)- 2 Yrs.	RDF (90:40:0:5 NPKZn Kg /ha)	90	196	2769	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2ml / litre at 30 and 50 DAS	67.5	147	2987	7.8	1.09
						RDF with 50 % N reduction & 2 Sprays of Nano N @ 2ml / litre at 30 and 50 DAS	45	98	2884	4.1	2.17
73	Western Dry Region (xiv)	Rajasthan	MPUAT, Udaipur, Rajasthan	Maize	Kharif 2020	RDF (90:40:30 NPK Kg/ ha)	90	196	3018	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @ 4 ml / litre	45	99	3912	29.6	2.17
74	Western Dry Region (xiv)	Rajasthan	SKNAU, Jobner, Rajasthan	Mustard	Rabi 2020-21	RDF (60:40:0 NPK Kg/ ha)	60	130	2460	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2 ml / litre at 35 and 55 DAS	45	98	2623	6.6	0.72

75	Western Dry Region (xiv)	Rajasthan	MPUAT, Udaipur, Rajasthan	Mustard	Rabi 2021-22	RDF (60:40:40 NPK Kg/ ha)	60	130	1402	-	-
						RDF with 25 % N reduction & 1 Sprays of Nano N & Zn @ 2 ml / litre at 30 DAS	45	98	1595	13.76	0.72
						RDF with 50 % N reduction & 1 Sprays of Nano N & Zn @ 2 ml / litre at 30 DAS	30	65	1486	5.99	1.45
76	Western Dry Region (xiv)	Rajasthan	SKNAU, Jobner, Rajasthan	Mustard	Rabi 2021-22	RDF (60:40:0 NPK Kg/ ha)	60	130	2411	-	-
						RDF with 50 % N reduction & 2 Sprays of Nano N @ 2 ml / litre at 30 and 45 DAS	30	65	2439	1.2	1.45
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2 ml / litre at 30 and 45 DAS	45	98	2676	9.7	0.72
77	Western Dry Region (xiv)	Rajasthan	SKNAU, Jobner, Rajasthan	Wheat	Rabi 2021-22	RDF (120:40:30 NPK Kg/ ha)	120	261	4610	-	-
						RDF with 25 % N reduction & 2 Sprays of Nano N @ 2.5ml / litre at 35 and 55 DAS	90	196	5231	13.5	1.45
78	Islands Region (xv)	Andaman & Port Blair	ICAR-CIARI, Bloomsdale Research Farm, Port Blair	Paddy	Rabi 2021-22	RDF (90:60:60 NPK Kg/ ha)	90	196	3593	-	-
						RDF with 33% N reduction & 2 Spray of Nano N @2ml/ Litre	60	130	3822	6.4	1.45
						RDF with 33% N reduction & 2 Spray of Nano N @4ml/ Litre	60	130	4110	14.4	1.45
79	Islands Region (xv)	Andaman & Port Blair	KVK Guptapara, Farmers Field, South & Middle Andaman (ICAR-CIARI, Port Blair Trial)	Paddy	Rabi 2021-22	RDF (90:60:60 NPK Kg/ ha)	90	196	3611	-	-
						RDF with 33% N reduction & 2 Spray of Nano N @2ml/ Litre	60	130	4019	11.3	1.45
						RDF with 33% N reduction & 2 Spray of Nano N @4ml/ Litre	60	130	4213	16.7	1.45
80	Islands Region (xv)	Andaman & Port Blair	KVK Nimbudera, Farmers Field, South & Middle Andaman (ICAR-CIARI, Port Blair Trial)	Paddy	Rabi 2021-22	RDF (90:60:60 NPK Kg/ ha)	90	196	3373	-	-
						RDF with 33% N reduction & 2 Spray of Nano N @2ml/ Litre	60	130	3572	5.9	1.45
						RDF with 33% N reduction & 2 Spray of Nano N @4ml/ Litre	60	130	3780	12.1	1.45

Summary of Nano DAP Trial Details (Kharif 2021 to Rabi 2023-24)

SN	Crop	Trial (No.)	Yield Increase (%)	Phosphorus (P2O5) reduction (%)	Trial Locations & Season
CEREALS					
1	Paddy	14	Upto 24.3%	25-50%	ICAR-RCER, Patna (<i>Kharif 2021</i>); CSKHPKV, Palampur, HP (<i>Kharif 2021 & Kharif 2022</i>); SKUAST, Jammu (<i>Kharif 2021</i>); AAU, Jorhat (<i>Kharif 2021</i>); BCKV, Nadia, WB (<i>Kharif 2021</i>); CSAUAT, Kanpur (<i>Kharif 2021</i>); BAU, Ranchi (<i>Kharif 2021</i>); JNKVV, Jabalpur (<i>Kharif 2021</i>); UAS, Raichur (<i>Kharif 2021 & Summer 2022</i>); ANGRAU, Guntur (<i>Kharif 2021</i>); KAU-IFSRS, Thrissur (<i>Rabi 2021-22</i>); UAHS, Shivamogga (<i>Kharif 2022</i>)
2	Wheat	10 (1 Pooled)	Upto 19.8%	25-50%	AAU, Gujarat (<i>Rabi 2021-22 & 2022-23-Pooled</i>); CSKHPKV, Palampur, HP (<i>Rabi 2021-22 & 2022-23</i>); SKUAST, Jammu (<i>Rabi 2021-22</i>); ICAR-RCER, Patna (<i>Rabi 2021-22</i>); CSAUAT, Kanpur, UP (<i>Rabi 2021-22</i>); BAU, Ranchi (<i>Rabi 2021-22</i>); SKNAU, Jobner (<i>Rabi 2021-22</i>); JNKVV, Jabalpur (<i>Rabi 2021-22</i>), I.Ag.Sc, BHU, Varanasi (<i>Rabi 2023-24</i>)
3	Maize	8 (1 Pooled)	Upto 17.7%	25-75%	AAU, Gujarat (<i>Kharif 2021 & 2022- Pooled</i>); ICAR-IIMR, Ludhiana (<i>Kharif 2021</i>); ICAR-CRIDA, Hyderabad (<i>Kharif 2021</i>); BAU, Ranchi (<i>Kharif 2021</i>); UAS, Raichur (<i>Kharif 2021 & Summer 2022</i>); UAS GVKV, Bangalore (<i>Kharif 2021</i>); MPUAT, Udaipur (<i>Kharif 2021</i>).
MILLETS					
4	Pearl Millet (Bajra)	1	3.4%	25%	RVSKVV, Gwalior (<i>Kharif 2021</i>)
5	Finger Millet (Ragi)	1	14.9%	50%	VCSG UHFF, Gharwal, Uttarakhand (<i>Kharif 2021</i>)
OILSEED					
6	Mustard	1	6.4%	50%	RVSKVV, Gwalior (<i>Rabi 2021-22</i>)
7	Rapeseed	1	2.0%	25%	BCKV, Nadia (<i>Rabi 2021-22</i>)
8	Soybean	1	5.9%	50%	RVSKVV, Gwalior (<i>Kharif 2021</i>)
9	Groundnut	2	0.8 - 7.0%	50%	SKNAU, Jobner (<i>Kharif 2021</i>)
PULSES					
10	Chickpea/ Gram	1	4.8%	50%	RVSKVV, Gwalior (<i>Rabi 2021-22</i>)
VEGETABLES					
11	Potato	4	2 - 15.7%	50-100%	SDAU, Dantiwada (<i>Rabi 2021-22 & 2022-23</i>); ANDUAT, Kumarganj, Ayodhya (<i>Rabi 2021-22</i>); UBKV, Coochbehar (<i>Rabi 2022-23</i>)
12	Okra	1	18.6%	50%	Anamalai Agriculture University, Chidambaram (<i>Summer 2022</i>)
13	Vegetable Cowpea	1	18.5%	50%	Anamalai Agriculture University, Chidambaram (<i>Kharif 2021</i>)
	Total	46			

Agro-climatic zone wise ICAR-Research Institutes/ State Agriculture Universities (SAUs) Trials on IFFCO Nano DAP (Liquid)

SN	Agro-Climatic Zone	State	Name of ICAR-Institutes/ SAUs/ KVKs	Crop	Season	N:P2O5:K2O (Kg/ha)	Nano DAP Dosage (ml/ kg seed) (ml/ lit. water)			Yield (Qt/ha)		% Inc over RDF	Phosphorus (P2O5) reduction
							Seed/ Root/ Tuber/ Sett Treatment	1st Foliar Spray	2nd Foliar Spray	RDF (100% NPK)	Nano DAP #		
1	Western Himalayan Region (i)	Uttarakhand	Veer Chandra Singh Garhwali Uttarakhand University of Horticulture & Forestry, Bharsar, Pauri Garhwal,	Finger Millet	Kharif 2021	40-20-20	5 ml	4 ml	4 ml	10.13	11.64	14.9	50%
2	Western Himalayan Region (i)	Jammu	Sher-e-Kashmir University of Agriculture Sciences & Technology (SKUAST), Jammu	Paddy	Kharif 2021	50-25-15	5 ml	4 ml	x	42.31	42.63	0.8	25%
3	Western Himalayan Region (i)	Jammu	Sher-e-Kashmir University of Agriculture Sciences & Technology (SKUAST), Jammu	Wheat	Rabi, 2021-22	100-50-25	5 ml	2 ml	x	47.29	47.89	1.3	25%
4	Western Himalayan Region (i)	Himachal Pradesh	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya (CSKHPKV), Palampur	Paddy	Kharif 2021	80-40-40	5 ml	4 ml	4 ml	50.64	52.46	3.6	50%
5	Western Himalayan Region (i)	Himachal Pradesh	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya (CSKHPKV), Palampur	Wheat	Rabi, 2021-22	120-60-30	5 ml	2 ml	x	35.57	36.1	1.5	25%
6	Western Himalayan Region (i)	Himachal Pradesh	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya (CSKHPKV), Palampur	Paddy	Kharif 2022	80-40-40	5 ml	4 ml	4 ml	46.97	48.11	2.4	25%
7	Western Himalayan Region (i)	Himachal Pradesh	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya (CSKHPKV), Palampur	Wheat	Rabi 2022-23	120-60-30	5 ml	4 ml	4 ml	37.15	38.10	2.6	25%
8	Eastern Himalayan Region (ii)	Assam	Assam Agricultural University, Jorhat (Assam)	Paddy	Kharif 2021	60-20-40	5 ml	4 ml	x	36	39.7	10.3	50%
9	Lower Gangetic Plains Region (iii)	West Bengal	Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Nadia	Paddy	Kharif 2021	60-30-30	5 ml	2 ml	x	39.45	42.5	7.7	50%
10	Lower Gangetic Plains Region (iii)	West Bengal	Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Nadia	Rapeseed	Rabi, 2021-22	80-40-40	5 ml	2 ml	x	7.52	7.67	2.0	25%
11	Lower Gangetic Plains Region (iii)	West Bengal	Uttar Banga Krishi Vishwavidyalaya, Cooch Behar, Pundibari	Potato	Rabi, 2022-23	200-150-150	2.5 ml	2 ml	2 ml	252.80	257.90	2.0	50%
12	Middle Gangetic Plain Region (iv)	Bihar	ICAR-Regional Complex for Eastern Region (RCER), Patna	Paddy	Kharif 2021	120-60-40	5 ml	4 ml	4 ml	57.5	60.4	5.0	50%
13	Middle Gangetic Plain Region (iv)	Bihar	ICAR-Research Complex for Eastern Region (RCER), Patna	Wheat	Rabi, 2021-22	150-60-40	5 ml	4 ml	4 ml	46.2	47.0	1.8	50%
14	Middle Gangetic Plain Region (iv)	Uttar Pradesh	Chandra Shekhar Azad University of Agriculture & Technology (CSAU&T), Kanpur	Paddy	Kharif 2021	120-60-60	5 ml	2 ml	2 ml	39.38	44.67	13.4	50%
15	Middle Gangetic Plain Region (iv)	Uttar Pradesh	Chandra Shekhar Azad University of Agriculture & Technology (CSAU&T), Kanpur	Wheat	Rabi, 2021-22	150-80-50	5 ml	2 ml	x	41.22	49.38	19.8	50%
16	Middle Gangetic Plain Region (iv)	Uttar Pradesh	Acharya Narendra Dev University of Agriculture & Technology (ANDUA&T), Kumarganj	Potato	Rabi, 2021-22	150-100-100	5 ml	2 ml	x	354	375.2	6.0	50%
17	Middle Gangetic Plain Region (iv)	Uttar Pradesh	Institute of Agricultural Sciences, Banaras Hindu University (BHU), Varanasi	Wheat	Rabi, 2023-24	120-60-60	5 ml	4 ml	4 ml	45.13	45.76	1.4	25%
18	Trans-Gangetic Plain Regions (vi)	Punjab	ICAR-Indian Institute of Maize Research (IIMR), Ludhiana	Maize	Kharif 2021	120-60-30	5 ml	4 ml	x	55.45	58.32	5.2	25%
19	Eastern Plateau & Hill Region (vii)	Jharkhand	Birsa Agricultural University, Ranchi, Jharkhand	Paddy	Kharif 2021	120-60-40	5 ml	2 ml	x	60.36	62.45	3.5	50%
20	Eastern Plateau & Hill Region (vii)	Jharkhand	Birsa Agricultural University, Ranchi, Jharkhand	Maize	Kharif 2021	150-60-80	5 ml	2 ml	x	43.22	44.63	3.3	50%
21	Eastern Plateau & Hill Region (vii)	Jharkhand	Birsa Agricultural University, Ranchi, Jharkhand	Wheat	Rabi, 2021-22	150-60-40	5 ml	2 ml	x	36.72	38.63	5.2	50%
22	Central Plateau & Hill Region/ Vindhya Plateau (viii)	Madhya Pradesh	Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur	Paddy	Kharif 2021	120-60-40	5 ml	4 ml	4 ml	56.8	65.9	16.0	50%
23	Central Plateau & Hill Region/ Vindhya Plateau (viii)	Madhya Pradesh	Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur	Wheat	Rabi, 2021-22	120-60-40	5 ml	4 ml	4 ml	42.06	56.35	34.0	50%
24	Central Plateau & Hill Region/ Vindhya Plateau (viii)	Madhya Pradesh	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (RVSKVV)	Soybean	Kharif 2021	20-80-40	5 ml	4 ml	4 ml	18.8	19.9	5.9	50%
25	Central Plateau & Hill Region/ Vindhya Plateau (viii)	Madhya Pradesh	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior	Pearlmillet/ Bajra	Kharif 2021	80-40-20	5 ml	4 ml	x	26.70	27.60	3.4	25%
26	Central Plateau & Hill Region/ Vindhya Plateau (viii)	Madhya Pradesh	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior	Chickpea/ Gram	Rabi, 2021-22	20-60-40	5 ml	2 ml	x	26.11	27.36	4.8	50%

SN	Agro-Climatic Zone	State	Name of ICAR-Institutes/ SAUs/ KVKs	Crop	Season	N:P2O5:K2O (Kg/ha)	Nano DAP Dosage (ml/ kg seed) (ml/ lit. water)			Yield (Qt/ha)		% Inc over RDF	Phosphorus (P2O5) reduction
							Seed/ Root/ Tuber/ Sett Treatment	1st Foliar Spray	2nd Foliar Spray	RDF (100% NPK)	Nano DAP #		
27	Central Plateau & Hill Region/ Vindhya Plateau (viii)	Madhya Pradesh	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior	Mustard	Rabi, 2021-22	80-40-20-30	5 ml	2 ml	x	20.37	21.67	6.4	50%
28	Southern Plateau & Hills (x)	Karnataka	University of Agriculture Science (UAS), Raichur	Paddy	Kharif 2021	100-50-50	5 ml	2 ml	x	56.35	60.12	6.7	50%
29	Southern Plateau & Hills (x)	Karnataka	University of Agriculture Science (UAS), Raichur	Maize	Kharif 2021	150-65-65	5 ml	2 ml	x	55.68	62.65	12.5	50%
30	Southern Plateau & Hills (x)	Karnataka	University of Agriculture Science (UAS), Raichur	Paddy	Summer, 2022	100-50-50	5 ml	2 ml	x	61.19	62.34	1.9	50%
31	Southern Plateau & Hills (x)	Karnataka	University of Agriculture Science (UAS), Raichur	Maize	Summer, 2022	150-65-65	5 ml	2 ml	x	54.55	60.15	10.3	50%
32	Southern Plateau & Hills (x)	Karnataka	University of Agriculture Science (UAS), GKVK, Bangalore	Maize	Kharif 2021	150-75-37.5	2.5 ml	2 ml	x	89.40	89.40	At Par	75%
33	Southern Plateau & Hills (x); Western Coast Plains and Ghat Regions (xii)	Karnataka	Keladi Shivappa Nayaka University of Agricultural & Horticultural Sciences, Shivamogga	Paddy	Kharif 2022	100-50-50	5 ml	2 ml	x	50.20	50.81	1.2	50%
34	Eastern Coastal Plains & Hills (xi)	Andhra Pradesh	Acharya N.G. Ranga Agriculture University (ANGRAU), Guntur	Paddy	Kharif 2021	90-60-60	5 ml	2 ml	x	55.37	67.07	21.1	50%
35	Southern Plateau & Hills (x)	Telangana	ICAR-CRIDA (Central Research Institute for Dryland Agriculture), Hyderabad	Maize	Kharif 2021	90-45-45-25	5 ml	2 ml	x	22.9	23.63	3.2	25%
36	Eastern Coastal Plains & Hills (xi)	Tamil Nadu	Annamalai Agriculture University, Chidambaram, Annamalai	Vegetable Cowpea	Kharif 2021	25-50-0	2.5 ml	2 ml	x	27.36	32.42	18.5	50%
37	Eastern Coastal Plains & Hills (xi)	Tamil Nadu	Annamalai Agriculture University, Chidambaram, Annamalai	Okra	Summer, 2022	40-50-30	2.5 ml	2 ml	x	57.22	67.87	18.6	50%
38	Western Coastal Plains & Ghats (xii)	Kerala	Kerala Agriculture University--Integrated Farming Systems Research Station	Paddy	Rabi, 2021-22	90-45-45	5 ml	2 ml	x	38.54	47.92	24.3	50%
39	Gujarat Plains & Hills (xiii)	Gujarat	Anand Agricultural University (AAU), Anand	Maize	Kharif 2021 & 2022 (Pooled)	120-60-0	5 ml	2 ml	x	54.40	56.00	2.9	25%
40	Gujarat Plains & Hills (xiii)	Gujarat	Anand Agricultural University (AAU), Anand	Wheat	Rabi 2021-22 & 2022-23 (Pooled)	120-60-0	5 ml	2 ml	x	59.39	59.94	0.9	25%
41	Gujarat Plains & Hills (xiii)	Gujarat	Sardarkrushinagar Dantiwada Agriculture University (SDAU), Dantiwada	Potato	Rabi, 2021-22	275-138-275	5 ml	6 ml	x	397.9	460.3	15.7	100%
42	Gujarat Plains & Hills (xiii)	Gujarat	Sardarkrushinagar Dantiwada Agriculture University (SDAU), Dantiwada	Potato	Rabi 2022-23	275-138-275	5 ml	2 ml	x	527.7	544.9	3.3	50%
43	Western Dry Region (xiv)	Rajasthan	Sri Karn Narendra Agriculture University (SKNAU), Jobner	Groundnut	Kharif 2021	15-60-30	2.5 ml	2 ml	x	39.62	42.41	7.0	50%
44	Western Dry Region (xiv)	Rajasthan	Sri Karn Narendra Agriculture University (SKNAU), Jobner	Groundnut	Kharif 2021	15-60-30	x	2 ml	2 ml	38.85	39.16	0.8	50%
45	Western Dry Region (xiv)	Rajasthan	Sri Karn Narendra Agriculture University (SKNAU), Jobner	Wheat	Rabi, 2021-22	120-40-30	5 ml	2 ml	x	47.05	48.2	2.4	50%
46	Western Dry Region (xiv)	Rajasthan	Maharana Pratap University of Agriculture & Technology, Udaipur	Maize	Kharif 2021	120-60-40	5 ml	2 ml	x	49.20	57.90	17.7	50%

Seed treatment of nano DAP @3-5 ml /kg seed and 1-2 sprays of nano DAP @ 0.2 % -0.4 %

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
1	International	Research	Nano Urea	Grain Yield and Nutrient Uptake of Rice as Influenced by the Nano Forms of Nitrogen and Zinc	2021	International Journal of Environment and Climate Change	10.9734/IJEC/C/2021/v11i7/304334	Rice	Results revealed that application of 50% conventional nitrogen fertilizer + foliar spray of 4 ml L-1 nano nitrogen at tillering and before panicle initiation stage + foliar spray of 2 ml L-1 nano zinc at tillering and before panicle initiation stage (T10) significantly increased the grain yield (6810 kg ha-1) and uptake of nitrogen (147.7 kg ha-1), phosphorous (30.0 kg ha-1), potassium (137.9 kg ha-1) and zinc (367 kg ha-1) which were on par with (T9) application of 50% conventional nitrogen fertilizer + foliar spray of 4 ml L-1 nano nitrogen at tillering and before panicle initiation stage.	Lahari, S., Hussain, S. A., Parameswari, Y. S., & Sharma, K. (2021). Grain yield and nutrient uptake of rice as influenced by the nano forms of nitrogen and zinc. <i>International Journal of Environment and Climate Change</i> , 11 (7), 1-6.
2	International	Review	Nano Urea	Nano Urea Liquid' – A Boon for Indian Farmers and Mother Earth	2021	Biotica Research Today	Biotica Research Today 2021 Vol.3:6 511-514	Not Applicable	Nano Urea Liquid', a first-of-its-kind product, is developed indigenously through proprietary technology at IFFCO's Nano Biotechnology Research Centre (NBRC) in Katol, Gujarat. The efficacy and production trials of the nano urea have been done in National Agriculture Research System (NARS), ICAR Research Institutes, State Agriculture Universities and Krishi Vigyan Kendras. The nano urea production will be done in three phases which might replace the use of conventional urea. Nanotechnology enabled the design of ultra-small urea particles that gave higher surface mass ratios, which get absorbed by the plants when sprayed on their leaves. The nano urea is capable of revolutionizing the entire agriculture sector all over the world. The nano fertilizer would be more sustainable than conventional urea for the environment and reduce input, logistics and storage costs. It is a boon for India in boosting the economy and farmers' livelihood while reducing the pollution on the mother earth.	Kiran, K., & Samal, K. C. (2021). 'Nano Urea Liquid'—A Boon for Indian Farmers and Mother Earth. <i>Biotica Research Today</i> , 3 (6), 511-514.
3	International	Review	Nanofertilizers	Nano Fertilizer on Sustainable Agriculture- A Review	2021	International Journal of Environment and Climate Change	10.9734/IJEC/C/2021/v11i8/30451	Not Applicable	Nano fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces. A report by Dwairi proposed that urea-impregnated zeolite may be utilised as a slow-release fertiliser, releasing nitrogen slowly and steadily from Nano zeolite. Zinc is one of the commonly deficient micronutrient in soil. A research by Raliya and Tarafdar in 2013 showed that zinc oxide, Nano Particles were shown to improve chlorophyll content, protein synthesis, rhizospheric microbial activity, acid phosphatase, alkaline phosphatase, and phytase activity in a cluster bean rhizosphere. Copper has characteristics of first transported to shoot and then retranslocated into root. An experiment on moong bean (<i>Vigna radiata</i>) and wheat revealed that nano copper could penetrate cell membrane and conglomerate thereafter.	Dutta, D., & Bera, A. (2021). Nano fertilizer on sustainable agriculture- A review. <i>International Journal of Environment and Climate Change</i> , 11 (8), 1-5.
4	International	Research	Nano Urea	Maximizing The Productivity And Profitability Of Summer Irrigated Greengram (<i>Vigna Radiata</i> L.) By Combining Basal Nitrogen Dose And Foliar Nutrition Of Nano And Normal	2022	International Journal Of Plant & Soil Science	10.9734/IJPS/S/2022/v34i2/231362	Moong	Experimental results, concluded that reduced application of basal nitrogen i.e., 80% RDN with nano urea foliar spray @ 4ml litre-1 of water at Flower initiation stage and 15 days thereafter found to be the optimal nitrogen dose and nano urea foliar nutrition for maximizing the productivity and profitability of summer irrigated green gram.	Saitheja, V., Senthivelu, M., Prabukumar, G., & Prasad, V. (2022). Maximizing the Productivity and Profitability of Summer Irrigated Greengram (<i>Vigna radiata</i> L.) by Combining Basal Nitrogen Dose and Foliar Nutrition of Nano and Normal Urea. <i>International Journal of Plant and Soil Science</i> , 34 (22), 109-116.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
5	International	Review	Nanoparticle	Nanoparticle'S Uptake And Translocation Mechanisms In Plants Via Seed Priming, Foliar Treatment, And Root Exposure: A Review	2022	Environmental Science And Pollution Research	https://doi.org/10.1007/s11356-022-23945-2	Not Applicable	The use of nanomaterials/nanoparticles in agriculture sector for crop improvement and protection against various environmental threats have attained greater significance. Size and nature of nanoparticles, mode of application, environmental conditions, rhizospheric and phyllospheric environment, and plant species are major factors that influence the action of nanoparticles. Recently, different methods for nanoparticle applications (seed priming, foliar, and root application) are being used to improve crop growth. This study comprehensively provides the knowledge of nanoparticles uptake via seed priming, foliar exposure, and root application, and their possible translocation mechanism within plants influenced by various factors that has not clearly presented and will provide new insights to find out an actual uptake and translocation mechanism	Khan, I., Awan, S. A., Rizwan, M., Hassan, Z. U., Akram, M. A., Tariq, R., ... & Xie, W. (2022). Nanoparticle's uptake and translocation mechanisms in plants via seed priming, foliar treatment, and root exposure: A review. <i>Environmental Science and Pollution Research</i> , 29 (60), 89823-89833.
6	International	Research	Nano Urea & Nano Zinc	Effect of nitrogen and zinc nanofertilizer with the organic farming practices on cereal and oilseed crops	2022	Scientific Reports	https://doi.org/10.1038/s41598-022-10843-3	Not Applicable	It was found that an average yield was recorded 5.35% higher in wheat, 24.24% higher yield in sesame, 4.2% higher in pearl millet and 8.4% higher yield in mustard by applying nanofertilizers of nitrogen and zinc along with the organic farming practice. The increased yield corroborated with the development parameters of plants such as wheat tillers, ear head length of pearl millet, capsule number per plant in sesame and siliquae number per plant in mustard	Kumar, A., Singh, K., & Verma, P. (2022). Effect of nitrogen and zinc nanofertilizer with the organic farming practices on cereal and oil seed crops. <i>Sci Rep</i> 12.
7	International	Research	Nano Urea	Cost-Effectiveness Of Foliar Application Of Nitrogenous Nano-Fertilizer To Mulberry and Cocoon Production	2022	Multilogic in Science	Not Applicable	Mulberry	Net returns per hectare of mulberry (Rs. 2,53,905 ha ⁻¹ crop-1) and B:C ratio (3.85) were more with foliar application of 0.4 percent nano nitrogen fertilizer with 50% soil N application 25 days after pruning and found to be cost effective as compared to other treatments.	Pooja L *, Narayana Reddy R1 And Banuprakash K. G2 "Cost-Effectiveness Of Foliar Application Of Nitrogenous Nano-Fertilizer To Mulberry Andcocoon Production" Vol. XII, Issue Xxxii, April 2022, Multilogic In Science, 10.20777/2022.12.02.11
8	International	Research	Nano Urea	Growth and productivity of rabi maize as influenced by foliarapplication of urea and nano-urea	2022	Crop Research	10.31830/2454-1761.2022.019	Maize	The study revealed that adoption of 100% RDN + foliar spray of nano-urea @ 4ml/L, twice at knee stage and tasseling stage was superior in influencing morphology, yield attributes and yield of rabi maize. However, since adoption of 75% RDN + foliar spray of nano urea @ 4ml/L at knee stageand tasseling stage was significantly at par with 100% RDN this might be a most appropriate managerial alternative to achieve sustainability.	Samui, S., Sagar, L., Sankar, T., Manohar, A., Adhikary, R., Maitra, S., & Prahara, S. (2022). Growth and productivity of rabi maize as influenced by foliar application of urea and nano-urea. <i>Crop Research</i> , 57(2), 100-110.
9	International	Research	Nano Urea	Effect of Foliar Application of Nano Urea on Productivity and Profitability of Fine Rice under Irrigated Subtropics of Jammu Region	2022	Indian Journal of Ecology	https://doi.org/10.55362/IJE/2022/3761	Rice	75% recommended N+ recommended PKZn + 2 Foliar Sprays of Nano urea each @ 2ml/liter of water recorded highest net returns and B:C ratio.	Attri, M., Sharma, N., & Sharma, B. C. (2022). Effect of foliar application of nano urea on productivity and profitability of fine rice under irrigated subtropics of jammu region. <i>Indian Journal of Ecology</i> , 49 (5), 1935-1938.
10	International	Research	Nano Urea	Growth And Yield Of Tea (Camelia Sinensis) As Influenced By Nano Urea During Pre And Post Pruning Operations	2023	International Journal Of Plant & Soil Science	https://doi.org/10.9734/ijps/2023/v35i203915	Tea	In tea crop, 50 days after pruning minimum time to attain tipping height and maximum bud breaking number (106/plant) was observed in 0.5% Nano Urea applied plot. To attain that height, lesser time was required (51 days) by the same plot. Plucking point density and green leaf yield was found maximum (50 no/m ²) during rain flush in 0.4% Nano Urea applied in 3 sprays.	Saikia, P., & Gogoi, A. S. (2023). Growth and Yield of Tea (Camellia sinensis) as Influenced by Nano Urea during Pre and Post Pruning Operation. <i>International Journal of Plant & Soil Science</i> , 35 (20), 1177-1185.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
11	International	Research	Nano Urea	Significance Of Nano N Fertilizer On Uptake, Efficiency And Yield Of Rice Crop	2023	Biological Forum – An International Journal	15(5):912-916(2023)	Rice	The results indicated that the treatments i.e. 100% RDF (T4), 75% N + 2 sprays of nano N @ 8 and 4 ml l-1 (T10 and T9), 50% N + 2 sprays of nano N @ 8 and 4 ml l-1 (T8 and T7) and 50% N + 3 sprays of 2% urea (T12) obtained significantly higher grain yield over the others while straw yield was found highest in 100% RDF (T4) followed by 75% N + 2 sprays of nano N @ 8 and 4 ml l-1 (T10 and T9) treatments in both the seasons. The highest total N uptake was found under T4 - 100% RDF (98.12 kg ha-1), T9 -75% N + 2 sprays of nano N @ 4 ml l-1 (94.25 kg ha-1) and T10 - 75% N + 2 sprays of nano N @ 8 ml l-1 (94.09 kg ha-1). Lastly, The Nitrogen Use Efficiency (NUE) was maximized 47.49% in 50%N + 2 sprays of nano N@4ml l-1 (T7) followed by 46.82 to 43.81% in different N levels combined with nano N and urea sprays.	Jagriti Patel, K. Tedia, Jyoti Bala, L.K. Srivastava, V.N. Mishra, R.K. Banwasi and Gourav Jatav (2023). Significance of Nano N Fertilizer on uptake, efficiency and Yield of Rice Crop. <i>Biological Forum – An International Journal</i> , 15(5): 912-916.
12	International	Research	Nano Urea	Effect Of Nano Urea On Growth, Yield And Nutrient Use Efficiency Of Okra Under Tropical Island Ecosystem	2023	International Journal Of Agricultural Sciences	10.15740/HAAS/19.RA.2023/134-139	Okra	The results revealed that nano spray resulted in higher okra yield (9.6 %) than NPK addition through chemical fertilizers. While increased concentration of nano spray (4%) had significant impact on the growth and yield parameters due to increased availability of N within the plant system. Though Rs. 600- 1200 respectively were incurred as additional cost on account of application of nano spray (0.2 - 0.4%), the nano spray (N66 PK and 0.4 % Nano urea) contributes to additional okra yield (1.32 t ha-1, 9.6%), additional monetary benefit (Rs.65,561) than only NPK addition through chemical fertilizers (100 % RDF). Further, there is significant difference between Nano spray at 0.2 % and 0.4% spray though higher concentration of (0.4%) nano spray gave 7.5-16 % higher yield and 17- 29 % higher netreturn. Further, the increased efficiency of nano urea resulted in saving of nitrogen fertilizer to the extent of 25-34%.	Subramani, T., Velmurugan, A., Bommayasamy, N., Swarnam, T. P., Ramakrishna, Y., Jaisankar, I., & Singh, L. (2023). Effect of Nano Urea on growth, yield and nutrient use efficiency of Okra under tropical island ecosystem. <i>International Journal of Agricultural Sciences</i> , 19 , 134-139.
13	International	Research	Nano Urea	Effect Of Nano Nitrogen On Growth And Yield Of Rice In Vertisols Of Chhattisgarh	2023	The Pharma Innovation	The Pharma Innovation Journal 2023; 12(5): 2124-2128	Rice	The results proved that the combined application of conventional and nano nitrogen had a positive influence on most of the growth parameters. The treatments with 100% RDF (T4), 75% N + 2 sprays of nano N @ 8 and 4 ml l-1 (T10 and T9), 50% N + 2 sprays of nano N @ 8 and 4 ml l-1 (T8 and T7) and 50% N + 3 sprays of 2% urea (T12) obtained significantly higher grain yield over the others in both the seasons. Also, the higher B:C ratio was obtained by the application of nano N combined with 50 and 75% RDN and 100% RDF.	Patel, J., Tedia, K., Srivastava, L. K., Bala, J., Jatav, G., & Mishra, V. N. (2023). Effect of nano nitrogen on growth and yield of rice in Vertisols of Chhattisgarh.
14	International	Research	Nano Urea	Quantitative And Qualitative Response Of Fodder Maize To Use Of Bulk And Nano-Fertilizers In North Western Plains Of India	2023	Agronomy	https://doi.org/10.3390/agronomy13071889	Fodder Maize	The study revealed that applying 50% of RDN through urea, along with dual foliar sprays of nano-urea, achieved comparable productivity to the 100% RDN through urea only.	Suryakanta Kashyap, Rakesh Kumar, Hardev Ram, Ashwani Kumar, Nirmalendu Basak, Parvender Sheoran, Subhradip Bhatacharjee, Bisworanjita Phool Singh Hindoriya, Birbal and Doohong Min, ICAR-National Dairy Research Centre, Karnal, India
15	International	Research	Nano Urea	Study Of Nitrogen Rates And Nano Urea Effects On Physiological Parameters And Yield Of Safflower (Carthamus Tinctorius L.)	2023	International Journal Of Environment And Climate Change	10.9734/IJEC/C/2023/v13i103071	Safflower	The result from the study suggests that application of urea as split doses and foliar spray of nano urea at reproductive stage is beneficial for the crop and will improve seed yield and oil quality of safflower. Foliar application of nano urea improves the nutrient uptake by the crop through its slow and controlled release of nutrients.	Gayathri, P. A., Ghuge, S. B., Shinde, S. A., Mahesh, S., & Pawar, A. V. (2023). Study of Nitrogen Rates and Nano Urea Effects on Physiological Parameters and Yield of Safflower (<i>Carthamus tinctorius</i> L.). <i>International Journal of Environment and Climate Change</i> , 13 (10), 3974-3981.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
16	International	Review	Nanofertilizers & Nanopesticides	Nano-Pesticides And Fertilizers: Solutions For Global Food Security	2023	Nanomaterials	https://doi.org/10.3390/nano14010090	Not Applicable	Nanotechnology emerges as an important way to safeguard global food security amid the escalating challenges posed by the expansion of the global population and the impacts of climate change. The perfect fusion of this breakthrough technology with traditional agriculture promises to revolutionize the way agriculture is traditionally practiced and provide effective solutions to the myriad of challenges in agriculture. Particularly noteworthy are the applications of nano-fertilizers and pesticides in agriculture, which have become milestones in sustainable agriculture and offer lasting alternatives to traditional methods. This review meticulously explores the key role of nano-fertilizers and pesticides in advancing sustainable agriculture. By focusing on the dynamic development of nanotechnology in the field of sustainable agriculture and its ability to address the overarching issue of global food security, this review aims to shed light on the transformative potential of nanotechnology to pave the way for a more resilient and sustainable future for agriculture.	Tang, Y., Zhao, W., Zhu, G., Tan, Z., Huang, L., Zhang, P., ... & Rui, Y. (2023). Nano-Pesticides and Fertilizers: Solutions for Global Food Security. <i>Nanomaterials</i> , 14 (1), 90.
17	International	Research	Nano Urea	Studies On Vegetative Growth Of Dragon Fruit [Hylocereus Costaricensis (Web.) Britton And Rose] As Influenced By Nano Urea, Urea, Fym And	2023	Environment And Ecology	Environment and Ecology 41 (1C) : 709—716, January–March 2023 ISSN 0970-0420	Dragon fruit	There was a significant increase in vegetative growth by nano urea in terms of various growth characters. Results suggested that nano urea was beneficial and resulted very close to the recommended dose of fertilizers (RDF). And, among the treatments under study, the nano urea @ 6 mL/l is recommended.	Maurya, A. K., Maj, S., Razauddin, Mayaram, Rawat, A. K., & Meena, R. C. (2023). Studies on vegetative growth of dragon fruit [Hylocereus costaricensis (Web.) Britton and Rose] as influenced by nano urea, urea, FYM and vermicompos.
18	International	Research	Nano Urea	Effect of Nano Nitrogen Fertilizer on Mulberry and its Influence on Larval and Cocoon Traits of Silkworm, Bombyx mori L. (FC1 x FC2)	2023	Mysore J. Agric.	https://doi.org/10.58321/AATCCReview.2023.11.04.322	Mulberry	The study resulted in significant improvement in the larval traits of silkworm fed with mulberry leaves with foliar application of nitrogen nano-fertilizer. Significantly shorter larval duration (4.73, 8.69 and 24.42 days, fourth instar, fifth instar and total larval duration, respectively), highest fifth instar larval weight (36.66 g /10 larvae), better effective rearing rate (97.78 %) were noticed in silkworms fed with leaves of mulberry with foliar application of 0.4 per cent nano nitrogen fertilizer on 25th day after pruning. However, significantly lowest fifth instar larval weight (26.72 g / 10 larvae), effective rearing rate (67.78 %) and longest fourth instar larval duration, fifth instar larval duration and total larval duration (5.51, 9.76 and 26.27 days) were observed in the silkworm group fed with mulberry leaves of absolute control. Significantly highest cocoon yield by weight (26.36 kg / 10000 worms), cocoon yield by number (9777 / 10000 worms), single cocoon weight (2.69 g), single cocoon shell weight (0.63 g) and cocoon shell ratio (23.28 %) was noticed in the silkworms fed with leaves of mulberry plants with foliar	Pooja, L., Banuprakash, K. G., Gowda, M., Reddy, R. N., & Satish, A. (2022). Effect of Nano Nitrogen Fertilizer on Mulberry and its Influence on Larval and Cocoon Traits of Silkworm, Bombyx mori L. (FC 1 x FC 2). <i>Mysore Journal of Agricultural Sciences</i> , 56 (2).
19	International	Research	Nano Urea, Nano DAP, Biofertilizer, Sagarika, City Compost	Effect of Organic manure, Bio-fertilizer and Nano-fertilizer on Yield and Economics of different Vegetable crops and soil nutrient status	2023	Research Square	https://doi.org/10.21203/rs.3.rs-2960032/v1	Vegetables	the effectiveness of organic manures, Nano Nitrogen and Nano Di-ammonium Phosphate (DAP) in respect to the untreated field environment were compared and studied on two important crops viz. cauliflower and tomato. Standard field conditions were optimised and on-farm trials in 40 different farms of sandy loam soil were conducted by IFFCO and KVK in village Khatawali, Rewari district of Haryana, Rabi season 2020-21 and 2021-22. The results of this study have clearly demonstrated the synergetic potential of organic manure, bio-fertilizer and nano-fertilizers with a rise of 12.2–15.4% yield in cauliflower and 12.6–14.9% yield in tomato. While the net return was increased by 25.8–31.7% in Cauliflower and 21.4–25.0% in Tomato as compared to T1 and T2. Extensive analysis is made on growth parameters such as the height of the plants, number of primary branches, average fruit weight that escalated the productivity of crops besides the forecast of beneficially effected economics i.e. Benefit Cost (B: C) ratio. Average data of post harvested soil indicated the enhanced organic carbon	Kumar, A., Singh, K., Sharma, S., Mishra, J. P., Sharmila, J. S., Kumar, Y., ... & Sivashankari, L. (2023). Effect of Organic manure, Bio-fertilizer and Nano-fertilizer on Yield and Economics of different Vegetable crops and soil nutrient status.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
20	International	Review	Nanotechnology	Nano-enabled strategies to enhance biological nitrogen fixation	2023	Nature nanotechnology	https://doi.org/10.1038/s41565-023-01392-5	Not Applicable	Increasing the capacity of biological nitrogen fixation (BNF) is an effective strategy to enhance food security while simultaneously reducing the carbon and nitrogen footprint of agriculture. Nanotechnology offers several pathways to enhance BNF successfully.	Li, M., Gao, L., White, J. C., Haynes, C. L., O'Keefe, T. L., Rui, Y., ... & Zhang, P. (2023). Nano-enabled strategies to enhance biological nitrogen fixation. <i>Nature Nanotechnology</i> , 18 (7), 688-691.
21	International	Review	Nanofertilizers	Nanofertilizers: The Next Generation of Agrochemicals for Long-Term Impact on Sustainability in Farming Systems	2023	Agrochemicals	https://doi.org/10.3390/agrochemicals2020017	Not Applicable	The pH of the soil is temporarily changed by chemical fertilizers, which kill the beneficial soil microflora and can cause absorption stress on crop plants. This leads to higher dosages during the application, causing groundwater leaching and environmental toxicity. Nanofertilizers (NFs) reduce the quantity of fertilizer needed in agriculture, enhance nutrient uptake efficiency, and decrease fertilizer loss due to runoff and leaching. Moreover, NFs can be used for soil or foliar applications and have shown promising results in a variety of plant species. The main constituents of nanomaterials are micro- and macronutrient precursors and their properties at the nanoscale. Innovative approaches to their application as a growth promoter for crops, their modes of application, and the mechanism of absorption in plant tissues are reviewed in this article. In addition, the review analyzes potential shortcomings and future considerations for the	Gade, A., Ingle, P., Nimbalkar, U., Rai, M., Raut, R., Vedpathak, M., ... & Abd-El Salam, K. A. (2023). Nanofertilizers: the next generation of agrochemicals for long-term impact on sustainability in farming systems. <i>Agrochemicals</i> , 2 (2), 257-278.
22	International	Research	Nano Urea	Effect of Nano Urea Foliar Spray on Yield and Yield Attributes of Black Gram (Vigna mungo L.)	2023	Journal of Agroforestry and Environment	https://doi.org/10.55706/jae	Black Gram	Foliar application of nano urea is a good option of nitrogen or a balanced dose of nitrogen to increase the yield of black gram. For that, this study was conducted to evaluate the performance of black gram (Vigna mungo L.) under two forms of nitrogen at the Bangladesh Institute of Nuclear Agriculture (BINA) sub-station experimental field, Chapainawabganj during September to December 2022. Black gram variety Binamash-2 and 3 treatments, viz. Control (no fertilizer) (T1), Farmers practice (recommended fertilizer application as basal dose and top dressing during active growth) (T2) and Nano urea (2-4 ml of nano urea (4 % N) in one litre of water and sprayed on crop leaves at its active growth stages) (T3) were used under randomized block design. Yield and yield contributing characters were significantly affected by different forms of nitrogen (urea). The highest grain yield was obtained with T3 which was 1587.33 kg per hectare whereas T1 had given the lowest yield (983.33 kg per hectare). It was obvious that grain yield of black gram can be increased substantially with the judicious application of nano urea as	Islam, M. Z. A., Alim, S. M. A., Hoque, M. M., Islam, M. M., & Adhikary, S. (2023). Effect of Nano Urea Foliar Spray on Yield and Yield Attributes of Black Gram (Vigna mungo L.). <i>Journal of Agroforestry and Environment</i> , 16(1), 64-66.
23	International	Review	Nano Urea	Climate-smart and resilient rice production practices in the MFS	2023	International Rice Research Institute	https://hdl.handle.net/10568/138506	Chiili	The rising concerns of over-exploitation of groundwater resources, increasing cost of inputs and cultivation, timely availability of labor and energy, degradation of soil health, and climate change prevail in major agri-food systems in Bangladesh. Thus, reversing the unsustainable way of practicing agriculture to climate-smart agriculture would be key to sustainable agricultural development and productivity. Climate Smart is an approach to agricultural production, that is concerned with the management of available resources, with the latest agricultural management practices and machinery, especially under a particular set of socio-economic and environmental conditions. It works to improve food security and sustainable development goals (SDGs). Therefore, if climate-smart agriculture is implemented at the right time, with the necessary resources, techniques, and knowledge in a particular area, it can lead to food security along with enhancing adaptive capacity and reducing GHG potential for sustainable agricultural production. In Bangladesh, the SI-MFS initiative has been working with some climate-smart agricultural	Ahmed, S., Miajy, A., Khatun, A. and Bhandari, H. 2023. Climate-smart and resilient rice production practices in the MFS. Los Baños, Philippines: IRR

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
24	International	Research	Nano Urea & Nano Zinc	Comparative Assessment Of Nano Nitrogen And Nano Zinc Nutrition On Growth, Yield And Profitability Of Chilli(Capsicum	2024	Journal Of Plant Nutrition	https://doi.org/10.1080/01904167.2024.2325949	Chilli	The experiment comprised combinations of recommended doses of nitrogen (RDN) (75, 100 & 125%) along with two foliar sources, nano (nN & nZn @ 0.4%) and conventional (urea @ 2% & ZnSO4@ 0.2%) against control. Application of 75% RDN with nN and nZn saved 25-50% of RDN compared to conventional sources. The results propose cutting nitrogen fertilizer by up to 50%, showcasing the eco-friendly aspect of nano-fertilizers.	Sunil, C., Kadam, P. V., Kanavi GB, J., Onte, S., Salimath, S. B., HR, J., ... & N, U. S. (2024). Comparative assessment of nano nitrogen and nano zinc nutrition on growth, yield and profitability of chilli (Capsicum annum. L). <i>Journal of Plant Nutrition</i> , 47(1), 1-15.
25	International	Research	Nano Urea & Nano Zinc	Changes In Microbial Community Structure And Yield Responses With The Use Of Nano-Fertilizers Of Nitrogen And Zinc In Wheat-Maize System	2024	Scientific Reports	https://doi.org/10.1038/s41598-023-48951-3	Wheat & Maize	The experimental data indicated that the application of foliar spray of nano-fertilizers along with 75% N as basal is a sustainable nutrient management approach with respect to growth, yield and rhizosphere biological activity. Furthermore, two foliar sprays of nano-N or nano-N + nano-Zn curtailed N requirement by 25%, enhanced soil microbial diversity and the microbial community structure.	Upadhyay, P. K., Dey, A., Singh, V. K., Dwivedi, B. S., Singh, R. K., Rajanna, G. A., ... & Shukla, G. (2024). Changes in microbial community structure and yield responses with the use of nano-fertilizers of nitrogen and zinc in wheat-maize system. <i>Scientific Reports</i> , 14(1), 1100.
26	International	Research	Nano Urea	Elucidating Morphogenic And Physiological Traits Of Rice With Nitrogen Substitution Through Nano nitrogenUnder Salt Stress Conditions	2024	Research Square	https://doi.org/10.21203/rs.3.rs-4015792/v1	Rice	With the onset of nano-formulations, this study was designed to explore the potential of nano-nitrogen by replacing traditional urea applications in 33, 50 and 60% doses on rice plant growth and development. Further, the strategic substitutions were compared in saline and sodic soils along with normal soils to dissect the beneficial response of nano-N in two rice varieties under saline stress of ECe ~ 6.0 dSm ⁻¹ and sodic stress of pH ~ 9.1. With saline and sodic stresses, plant RWC decreased by 10.33% and total chlorophyll content by 1.32–1.52%, gas exchange attributes by 10.42–38.8%, leaf area upto 29.9% and yield upto 3.92%, respectively. Leaf greenness (SPAD index) was significantly higher with Nano-N along with number of grains/panicle, crop growth rate and net assimilation rate. Results depicted superiority of nitrogen replacement through nano-N with 0.2–1.64% enhancement in growth traits, 0.93–1.85% in physiological traits, and 1.92% in yield over 100% recommended dose of urea on cumulative basis in rice. Between varieties, salt tolerant rice variety, CSR-10 performed better than Pusa	Kumar, A., Sheoran, P., Kumar, N., Devi, S., Kumar, A., Malik, K., ... & Mann, A. (2024). Elucidating morphogenic and physiological traits of rice with nitrogen substitution through nano-nitrogen under salt stress conditions.
27	International	Research	Nano Urea	Effects Of Nano Urea On Growth And Gene Expression Of 1 Arabidopsis Thaliana 2 In Hydroponics	2024	Pre-Prints	https://doi.org/10.1101/2024.03.20.585664	Arabidopsis Thaliana	A growth experiment in a nitrogen-free hydroponic medium compared the effects of a liquid nano urea formulation (NUF) marketed by Indian Farmers Fertilizer Cooperative (IFFCO) to an equimolar bulk urea. Transcriptome analysis identified the molecular mechanisms of growth enhancement. Dynamic light scattering and transmission electron microscopy confirmed NUF's negative surface charge and sub-100 nm size, correlating its uptake and distribution in the plant. A two-week growth in the hydroponic medium with 70 µM NUF led to a 20% higher biomass and 16% higher chlorophyll content than a medium with 70 µM urea. Higher doses of NUF inhibited growth, whereas higher equivalent urea doses did not. NUF led to the differential expression of more genes than urea at 12 h to seven days of treatment. Nitrogen assimilation, growth, photosynthesis, and stress tolerance genes showed higher transcript levels in NUF than in urea. On the other hand, NUF led to greater suppression of many negative growth-regulating genes. After seven days of treatment, chlorophyll biosynthesis genes got up-	JANGID, N., Marik, D., Verma, D., Dey, A., Shekhawat, R. S., Patel, D., ... & Sadhukhan, A. (2024). Effects of nano urea on growth and gene expression of Arabidopsis thaliana in hydroponics. <i>bioRxiv</i> , 2024-03.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
28	International	Review	Naofertilizers	Advances In Agricultural Technology: A Review Of Slow-Release Nanofertilizers And Innovative Carriers	2024	Communications In Soil Science And Plant Analysis	https://doi.org/10.1080/00103624.2024.2326145	Not Applicable	A notable approach in nanofertilizer formulation is the controlled release of nutrients, ensuring a steady and gradual availability of essential elements to plants throughout their growth cycle. This approach curtails excessive fertilizer application, reduces leaching, minimizes negative environmental impact, and enhances nutrient utilization efficiency. Innovative carriers, in turn, play a fundamental role in the precise delivery of nutrients. Eco-friendly materials are being explored as sustainable alternatives to encapsulate the nutrients, ensuring they are available to plants when needed. Therefore, this review article highlights promising advancements in agricultural technology, with a focus on the utilization of slow-release nanofertilizers and innovative carriers as sources of essential nutrients such as nitrogen, phosphorus, and potassium in agricultural practices, emphasizing the use of these technologies to promote environmental sustainability and agricultural efficiency.	Sales, H. B., de S. Carolino, A., de A. Nunes, R. Z., Macalia, C. M., Ruzo, C. M., da C. Pinto, C., ... & Sanches, E. A. (2024). Advances in Agricultural Technology: A Review of Slow-Release Nanofertilizers and Innovative Carriers. <i>Communications in Soil Science and Plant Analysis</i> , 1-34.
29	International	Review	Naofertilizers	Nitrogen-Based Nanofertilizers: Raw Materials, Nitrogen Assimilation By The Plant, And Physicochemical Variables That Affect Their Release	2024	Nanofertilizer Synthesis (Book Chapter) ISBN: 9780443135354	https://doi.org/10.1016/B978-0-443-13535-4.00021-3	Not Applicable	Nanotechnology has been applied in the food industry for these needs, where nanofertilizers have gained popularity over conventional fertilizers. There is a high interest in nitrogen nanofertilizers due to the importance of nitrogen to plants. Several researchers have focused on the development of this type of fertilizer. Despite this, those based on synthetic polymers are controversial due to their low biodegradability. As an alternative, biopolymers are a more environmentally friendly option; however, more studies are needed to know the long-term effects on crops and large-scale production. Nitrogenous nanofertilizers are intended to be used in crop fields. Despite that, it is not possible to regulate climatic variables, and little can be done for soil conditions, which greatly influence fertilizer release patterns and biodegradability.	Guadalupe, Á. M. M., Gregorio, B. U. C., Madera-Santana, T. J., Francisco, R. F., & Agustín, T. H. J. (2024). Nitrogen-based nanofertilizers: raw materials, nitrogen assimilation by the plant, and physicochemical variables that affect their release. In <i>Nanofertilizer Synthesis</i> (pp. 161-178). Elsevier.
30	International	Research	Nano Urea	Combined Application Of Inorganic Fertilizer And Organic Manure With Nano Urea On Growth And Yield Of Scented Rice	2024	International Journal Of Plant & Soil Science	DOI: 10.9734/IJPS/S/2024/v36i54527	Rice	The results of present study revealed that application of 75% N through urea + Azospirillum @ 5 kg ha ⁻¹ + FS with Nano urea @ 4 ml litre ⁻¹ at active tillering (AT) and panicle initiation (PI) stage registered maximum plant height (113.44 and 107.52 cm, respectively), no. of tillers hill ⁻¹ (21.88 and 19.49, respectively) during both the years of experimentation. As regard to yield and yield attributes significantly maximum total no. of grains panicle ⁻¹ (81 and 78, respectively), panicle length (28.23 and 27.19 cm, respectively), grain (4780 and 4418 kg ha ⁻¹ , respectively) and straw yield (6652 and 6432 kg ha ⁻¹ , respectively) was recorded with the application of 75% N through urea + Azospirillum @ 5 kg ha ⁻¹ + FS with Nano urea @ 4 ml litre ⁻¹ at AT and PI stage.	Gajbhiye, M., Agrawal, K. K., Jha, A. K., & Kumar, N. (2024). Combined Application of Inorganic Fertilizer and Organic Manure with Nano Urea on Growth and Yield of Scented Rice. <i>International Journal of Plant & Soil Science</i> , 36 (5), 293-300.
31	International	Research	Nano Urea, Nano Zinc & Nano Copper	Unveiling the combined effect of nano fertilizers and conventional fertilizers on crop productivity, profitability, and soil well-being	2023	Frontiers in Sustainable Food Systems	10.3389/fsufs.2023.1260178	Maize, Wheat, Pearl millet and mustard	Study was formulated to evaluate the effectiveness of nano-N (nano-urea), nano-Zn, and nano-Cu at varying N levels [0, 50, 75, and 100% of the recommended rates of nitrogen (RRN)] on maize-wheat and pearl millet-mustard systems during 2019–20 and 2020–21. The results exhibited that the application of nano-N + nano-Zn with 100% RRN exhibited significantly higher grain yields in maize (66.2–68.8%), wheat (62.6–61.9%), pearl millet (57.1–65.4%), and mustard (47.2–69.0%), respectively, over absolute control plots and combinations of three nano-fertilizers like nano-N + nano-Zn + nano-Cu applied plots. This was mainly attributed to the higher N and Zn uptake by the crops. However, 75% RRN with nano-N + nano-Zn also produced comparable yields. Thus, applying nano-N and nano-Zn via foliar applications, in conjunction with conventional urea, has the potential to reduce the required nitrogen fertilizer amount by up to 25%, while simultaneously maintaining equivalent yield levels. Similarly, 100% RRN and 75% RRN + nano-N + nano-Zn registered comparable profitability, soil mineral N, dehydrogenase	Upadhyay, P. K., Singh, V. K., Rajanna, G. A., Dwivedi, B. S., Dey, A., Singh, R. K., ... & Rawat, S. (2023). Unveiling the combined effect of nano fertilizers and conventional fertilizers on crop productivity, profitability, and soil well-being. <i>Frontiers in Sustainable Food Systems</i> , 7, 1260178.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
32	National	ICAR Technology Data Repository	Nano Urea	Nano Urea for increasing turmeric productivity and reducing the conventional Urea requirement	2024	KRISHI: Techno	Not Applicable	Turmeric	The turmeric dry rhizome yield in 50% soil N + 0.2% nano urea was on par with 100% soil N and application giving an additional advantage of reduction of N application rate by 50% through foliar supplementation of @ 0.2% nano urea as a strategy for higher use efficiency of applied N fertilizers. This has resulted in more efficient use of N by the crop giving equivalent yield as that of recommended dose of fertilizers. The nutrient uptake of major nutrients also found to be significantly higher in 50% N + 0.2% nano urea as the	Not Applicable
33	International	Research	Nano Urea	Studies on comparison of nano-urea and prilled urea for enhancing maize (Zea mays) growth and productivity	2024	Indian Journal of Agricultural Sciences	https://doi.org/10.56093/ijas.v94i3.143292	Maize	Results showed that root weight (fresh and dry), partial factor productivity (N, P2O5 and K2O), N concentration (grain and stover), grain yield, biological yield and harvest index of maize were all significantly affected by the application of various N rates and nano-fertilizers. The grain yield of maize was comparable to the yield obtained under RDF and 75% of the recommended N + two nano-urea sprays. These findings indicate that the concurrent use of these nano-fertilizers has the potential to reduce N fertilization by as much as 25%.	Rawat, S., Singh, R. K., Singh, P., Upadhyay, P. K., Shekhawat, K., Sangwan, S., Dash, S., Mondal, B. K. & Shukla, R. (2024). Studies on comparison of nano-urea and prilled urea for enhancing maize (Zea mays) growth and productivity. The Indian Journal of Agricultural Sciences, 94(3), 325-328.
34	International	Research	Nano Zinc	Zinc oxide nano-fertilizer differentially effect on morphological and physiological identity of redox-enzymes and biochemical attributes Zinc oxide nano-fertilizer differentially effect on morphological and physiological	2024	Scientific Report	https://doi.org/10.1038/s41598-024-63987-9	Wheat	The study focused on crude extract of Withania coagulans as reducing agent for the green synthesis of ZnO nanoparticles. Biosynthesized ZnO NPs were characterized by UV-Vis spectroscopy, XRD, FTIR and GC-MS analysis. However, zinc oxide as green Nano fertilizer was used to analyze responses induced by different doses of ZnO NPs [0, 25, 50, 100, 200 mg/l and Zn acetate (100 mg/l)] in Triticum aestivum (wheat). The stimulatory and inhibitory effects of foliar application of ZnO NPs were studied on wheat (Triticum aestivum) with aspect of biomass accumulation, morphological attributes, biochemical parameters and anatomical modifications. Wheat plant showed significant (p < 0.01) enhancement of growth parameters upon exposure to ZnO NPs at specific concentrations. In addition, wheat plant showed significant increase in biochemical attributes, chlorophyll content, carotenoids, carbohydrate and protein contents. Antioxidant enzyme (POD, SOD, CAT) and total flavonoid content also confirmed nurturing impact on wheat plant. Increased stem, leaf and root anatomical parameters,	Nazir, M. A., Hasan, M., Mustafa, G., Tariq, T., Ahmed, M. M., Golzari Dehno, R., & Ghorbanpour, M. (2024). Zinc oxide nano-fertilizer differentially effect on morphological and physiological identity of redox-enzymes and biochemical attributes in wheat (Triticum aestivum L.). Scientific Reports, 14(1), 13091.
35	International	Research	Nano Urea	Nano Urea Outperforms Equimolar Bulk Urea in the Hydroponic Growth of Arabidopsis thaliana by Inducing Higher Levels of Nitrogen Assimilation and Chlorophyll Biosynthesis Genes	2024	Journal of Plant	https://doi.org/10.1007/s00344-024-11581-8	Arabidopsis thaliana	Dynamic light scattering and transmission electron microscopy confirmed NUF's negative surface charge and sub-100-nm size, suitable for its uptake and distribution in the plant. A two-week growth in a nitrogen-free hydroponic medium with 70 µM NUF led to a 20% higher biomass and 16% higher chlorophyll content than a medium with 70 µM urea. Higher doses of NUF inhibited growth, whereas higher equivalent urea doses did not. Transcriptome analysis revealed that NUF led to the differential expression of more genes than urea at 12 h to seven days of treatment. Nitrogen assimilation, growth, photosynthesis, and stress tolerance genes showed higher transcript levels in NUF than in urea. On the other hand, NUF led to greater suppression of many negative growth-regulating genes. After seven days of treatment, chlorophyll biosynthesis genes were up-regulated, while chlorophyll catabolism genes down-regulated at higher levels by NUF than by urea, correlating with the higher chlorophyll content of NUF-treated seedlings. In conclusion, NUF outperformed equimolar urea for the growth promotion of A. thaliana at	Jangir, N., Marik, D., Verma, D., Dey, A., Shekhawat, R. S., Patel, D., Yadav, P., Sankhala, K., & Sadhukhan, A. (2024). Nano Urea Outperforms Equimolar Bulk Urea in the Hydroponic Growth of Arabidopsis thaliana by Inducing Higher Levels of Nitrogen Assimilation and Chlorophyll Biosynthesis Genes. Journal of Plant Growth Regulation, 1-27.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
36	International	Research	Nano Zinc	Raise of Nano-Fertilizer Era: Effect of Nano Scale Zinc Oxide Particles on the Germination, Growth and Yield of Tomato (Solanum lycopersicum)	2018	International Journal of Current Microbiology and Applied Sciences	https://doi.org/10.20546/jicmas.2018.705.219	Tomato	In the present study, an attempt was made to study the effect of nano zinc oxide particle (ZnO NPs) for improving yield and Zn content in tomato plant. Initially seed priming concentration were standardized in vitro using ZnO NPs (400ppm) and granular zinc sulphate (ZnSO ₄) (800ppm). Further standardized seed priming concentrations with different combinations of treatment such as seed priming, seed priming+ foliar spray and foliar spray were studied under field condition to evaluate their effect on biomass and Zn accumulation. The obtained results based on the physiological and yield parameters showed that the usage of ZnO NPs fertilizers through any of the method of application has significant positive effect compared to zinc sulphate. ICP-OES analysis of plant digested material revealed that uptake of ZnO NPs is higher than the granular ZnSO ₄ .	Hajira Khanm, B.A. Vaishnavi and Shankar, A.G. 2018. Raise of Nano-Fertilizer Era: Effect of Nano Scale Zinc Oxide Particles on the Germination, Growth and Yield of Tomato (Solanum lycopersicum). Int.J.Curr.Microbiol.App.Sci. 7(05): 1861-1871.
37	International	Research	Nano DAP	Strategic management of nano-fertilizers for sustainable rice yield, grain quality, and soil health	2024	Frontiers in Environmental Science	10.3389/fenvs.2024.1420505	Rice	The result revealed that plant height, panicle length, number of tillers hill ⁻¹ , total number of grain panicle ⁻¹ , and root length were maximum in T10 treatment (50% of the soil test recommended doses (STD) for N and P + seedling root dipping (SRD) with nano DAP at 5 mL L ⁻¹ + twice foliar sprays (FS) with nano DAP at 4mL L ⁻¹ at 25 and 45 DAT (date after transplanting). The integrated application of 50% STD for N and P + SRD with nano DAP at 5mL L ⁻¹ + twice FS with nano DAP at 4 mL L ⁻¹ at 25 and 45 DAT application can be a suitable substitute for conventional DAP and urea for rice in climate-smart agriculture as it possibly reduces environmental pollution while undisturbing crop	Sahoo BR, Dash AK, Mohapatra KK, Mohanty S, Sahu SG, Sahoo BR, Prusty M and Priyadarshini E (2024) Strategic management of nanofertilizers for sustainable rice yield, grain quality, and soil health. Front. Environ. Sci. 12:1420505.
38	International	Review	Nanofertilizers	Molecular mechanisms of plant productivity enhancement by nano fertilizers for sustainable agriculture	2024	Plant Molecular Biology	https://doi.org/10.1007/s11103-024-01527-9	Not Applicable	Foliar and root applications of NFs lead to their successful uptake by the plant, depending on the size, surface charge, and other physicochemical properties of NFs. Smaller NFs can pass through channels on the waxy cuticle depending on the hydrophobicity, while larger NFs pass through the stomatal conduits of leaves. The expression levels of nutrient transporter genes are regulated by NFs, controlling uptake and minimizing excess nutrient toxicity. Accelerated growth by NFs is brought about by their extensive regulation of cell division, photosynthesis, carbohydrate, and nitrogen metabolism, as well as the phytohormone-dependent signaling pathways related to development, stress response, and plant defense. NFs mimic Ca ₂₊ eliciting second messengers and associated proteins in signaling cascades, reaching transcription factors and finally orchestrating gene expression to enhance growth and stress	Dey, A., & Sadhukhan, A. (2024). Molecular mechanisms of plant productivity enhancement by nano fertilizers for sustainable agriculture. Plant Molecular Biology, 114(6), 128.
39	International	Research	Nano Zinc	Zinc Delivery to Plants through Seed Coating With Nano Zinc Oxide Particles	2024	Journal Of Plant Nutrition	http://dx.doi.org/10.1080/01904167.2015.1087562	Maize, Soybean, Pigeon pea and Lady finger	In this present investigation, a protocol has been developed to coat the seeds of maize (Zea mays L.), soybean (Glycine max L.), pigeon pea (Cajanas cajan L.) and ladies finger (Abelmoschus esculentus L.) with microns scale (<3 µm) and nano scale (<100 nm) ZnO powder @ 25 mg Zn/g seed and @ 50 mg Zn/g seed. Different Zn sources, ethyl alcohol, and crude pine oleoresin (POR) were used for coating of seeds. The germination test carried out with coated and uncoated seeds indicated better germination percentage (93-100%) due to ZnO coating as compared to uncoated seeds (80%). germination test carried out with coated and uncoated seeds indicated better germination percentage (93-100%) due to ZnO coating as compared to uncoated seeds (80%). Crop growth with ZnO coated seeds were similar to that observed with soluble Zn treatment applied as zinc sulfate heptahydrate (ZnSO ₄ .7H ₂ O) (@ 2.5 ppm Zn) which is evident from the periodic SPAD reading taken after 20, 25, 30 and 45 days after sowing.	Dey, A., & Sadhukhan, A. (2024). Molecular mechanisms of plant productivity enhancement by nano fertilizers for sustainable agriculture. Plant Molecular Biology, 114(6), 128.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
40	International	Research	Nano Urea, Nano DAP, Nano Potassium	Impact of Nano-Fertilizers and Modified Indigenous Minerals on Biomass Accumulation, Root Growth, and Soil Parameters in Wheat	2024	Journal of Soil Science and Plant Nutrition	https://doi.org/10.1007/s42729-024-01857-z	Wheat	Preparation and utilization of modified indigenous mineral product (MIMP) in tandem with nano fertilizers as an alternative to the recommended practices. The study involved three sources of phosphorus (P) and potassium (K) in horizontal factors and four sources of nitrogen (N) in vertical factors including control, organized in strip plot. MIMP is a multnutrient source. Dry matter accumulation was comparable for three horizontal factors; for basal + 2 sprays of nano urea (NU) and recommended dose of nitrogen (RDN). Root length density, surface area density and dry weight were 20-21%, 14-19% and 25-29% higher, respectively with application of MIMP along with nano diammonium phosphate (nano DAP) or nano potassium (nano K) as compared to the recommended P & K. Significant population of bacteria (73-74 ×105 CFU g-1 soil), and actinomycetes (49.7-49.8 ×105 CFU g-1 soil); dehydrogenase, alkaline and acid phosphatase activity were reported with MIMP + nanofertilizers. Comparable values of microbial population, and enzymatic activities were reported with basal application + 2 sprays of NU and RDN.	Sunil, C., Kadam, P. V., Kanavi GB, J., Onte, S., Salimath, S. B., HR, J., & N, U. S. (2024). Comparative assessment of nano nitrogen and nano zinc nutrition on growth, yield and profitability of chilli (Capsicum annum. L). Journal of Plant Nutrition, 1-15.
41	International	Research	Nano Urea	Effect of different sources of nitrogen on productivity, profitability and N use efficiency of fodder oat (Avena sativa)	2024	Indian Journal of Agronomy	10.59797/ija.v69i3.5530	Oat	The experiment consisted of seven treatments viz. control (no N); recommended dose of N (RDN); 50% N through fertilizer + 50% N through FYM; 50% N through fertilizer + 50% N through vermicompost; 50% N through fertilizer + two sprays of nano-urea; two spray of nano-urea and site-specific nitrogen management (SSNM). Results showed that application of 50% RDN through fertilizer + two sprays of nano-urea produced 58.3 t/ha green fodder which was at par with all other treatments except two sprays of nano urea and control. However, green fodder yield reduced under two foliar sprays of nano-urea by 20.7% as compared to 100% RDN (59.2 t/ha). The SSNM treatment recorded the highest net returns (49947/ha) and benefit to cost ratio (1.45) which were significantly higher than all other treatments except 100% RDN and 50% RDN through fertilizer + two sprays of nano-urea. The nano-urea treatments exhibited the highest nitrogen use efficiency. The study suggested that 50% recommended dose of nitrogen through conventional fertilizer along with two sprays of	Adhikari, T., Kundu, S., & Rao, A. S. (2016). Zinc delivery to plants through seed coating with nano-zinc oxide particles. Journal of Plant Nutrition, 39(1), 136-146.
42	International	Research	Nano Urea	Different nitrogen levels with nano and prilled urea spray on productivity and profitability of maize (Zea mays) in alfisols of Jharkhand	2024	Indian Journal of Agronomy	10.59797/ija.v69i3.5529	Maize	Twelve different combinations of conventional prilled urea, nano and prilled urea spray were investigated in the study. Different treatments included applying prilled urea as a 2% solution in 150 liters of water per hectare and nano-urea at a rate of 1250 ml/acre applied twice through foliar application. Results showed that applying two additional applications of nano-urea along with 75% of the recommended dose of prilled-urea was the most successful fertilization strategy.	Jayara, A. S., Kumar, R., Shukla, A., Singh, A. V., Singh, A. P., Pandey, P., Singh, N. K. & Bhatt, M. K. (2024). Impact of Nano-Fertilizers and Modified Indigenous Minerals on Biomass Accumulation, Root Growth, and Soil Parameters in Wheat. Journal of Soil Science and Plant Nutrition, 24(3), 4581-4596.
43	International	Review	Nano Zinc	Nano zinc, an alternative to conventional zinc as animal feed supplement: A review	2016	Animal Nutrition	http://dx.doi.org/10.1016/j.aninu.2016.06.003	Not Applicable	Zinc oxide nanoparticles are the specially prepared mineral salt having particle size of 1 to 100 nm. It promotes growth can act as antibacterial agent, modulates the immunity and reproduction of the animals. Apart from being highly bioavailable, reports have already pointed out the growth promoting, antibacterial, immuno-modulatory and many more effects of nano zinc (nZn). These can be used at lower doses and can provide better result than the conventional Zn sources and indirectly prevents environmental contamination also. Studies been undertaken in diversified animal species and encouraging effects have been reported with nZn supplementation. However, there is a need to optimize the dose and duration of ZnO NP supplementation	Kumar, P., Choudhary, M., Prasad, M., Kumar, A., Singh, S., & Kantwa, S. R. (2024). Effect of different sources of nitrogen on productivity, profitability and N use efficiency of fodder oat (Avena sativa). Indian Journal of Agronomy, 69(3).

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
44	International	Research	Nano Urea	Biologically synthesised urea-based nanomaterial shows enhanced agronomic benefits in maize and rice crops during Kharif season	2023	Scientia Horticulturae	https://doi.org/10.1016/j.scienta.2023.111988	Maize	Urea nanoparticles (TNU) developed by using a precise bio-fermentation method has been evaluated in this study as a Nitrogen supplement to urea when the recommended dosage of urea is reduced by 25 and 50%. Ten treatments having various combinations of conventional and nano nitrogen sources were laid out, TNU was applied through foliar applications and seed dressing. From the results, it was observed that the fertilising treatment having the combination of 75% dose of the conventional fertiliser in addition with TNU applications as the supplementary nitrogen source, outperformed the other treatments in terms of growth, yield and cost to benefit parameters in case of both maize	Rawat, S., Singh, R. K., Singh, P., Upadhyay, P. K., Shekhawat, K., Sangwan, S., Dash, S., Mondal, B. K. (2024). Different Nitrogen Levels with Nano and Prilled Urea Spray on Productivity and Profitability of Maize (Zea mays L.) in alfisols of Jharkhand. Indian Journal of
45	International	Research	Nano Zinc	Zinc nano and zinc ethylenediaminetetraacetic acid (EDTA) mediated water deficit stress alleviation in pearl millet (Pennisetum glaucum (L.) R. Br.): Photosystem II electron transport and pigment dynamics	2024	Plant Stress	https://doi.org/10.1016/j.stress.2024.100651	Pearl millet	Results indicated that water stress created a "traffic jam" like situation in the electron transport system of Photosystem II, leading to decreased photosynthetic efficiency. Treatments with water deficit stress + Zn Nano (particle size < 90 nm) spray with Zn concentration at 20 mg/L and water deficit stress + Zn EDTA spray (solid material size ~ 100 µm) with Zn concentration at 240 mg/L effectively ameliorated water deficit stress by its action on flux ratio parameters viz., quantum yield for electron transport (φE0), probability of electron transport beyond QA (ψ0) and quantum yield of electron transport from QA ⁻ to PS1 end electron acceptors (φR0) and also the specific fluxes and phenomenological fluxes. These treatments positively influenced chlorophyll content, and xanthophyll components, including violaxanthin, antheraxanthin, and zeaxanthin, and reduced NPQ and the de-exoxidation state. Higher concentrations of Zn Nano foliar spray (water stress + Zn Nano spray Zn @ 30 mg L ⁻¹) did not ameliorate water deficit stress as effectively as the lower concentrations, although this higher concentration was	Swain, P. S., Rao, S. B., Rajendran, D., Dominic, G., & Selvaraju, S. (2016). Nano zinc, an alternative to conventional zinc as animal feed supplement: A review. Animal Nutrition, 2(3), 134-141.
46	International	Research	Nano Zinc	Study on Nano Zn, Inorganic, and Organic Nutrient Management Practices and Their Impact on Nutrient Availability in Kharif Maize (Zea mays L.)	2024	Journal of Scientific Research and Reports	https://doi.org/10.9734/jsrr/2024/v30i102449	Maize	The experiment followed a split-plot design, with organic manures (Control, FYM at 10 t/ha, and Vermicompost at 5 t/ha) as the main plot treatments and various nutrient management strategies (Control, 75% RDF, 75% RDF + ZnSO ₄ at 25 kg/ha, 75% RDF + Nano-Zn at 10 mL/litre, 100% RDF, 100% RDF + ZnSO ₄ , and 100% RDF + Nano-Zn) as the subplot treatments. Results showed that combining 100% RDF with Nano-Zn and ZnSO ₄ significantly enhanced soil nutrient availability and improved physico-chemical properties compared to control treatments. The organic carbon content was highest in the 100% RDF + Nano-Zn treatment (0.492%), suggesting an increase in soil organic matter. Nitrogen availability was significantly higher in this treatment, with a pooled value of 151.167 kg/ha, compared to 143.443 kg/ha in the control. Phosphorus availability also increased in the 100% RDF + Nano-Zn treatment (16.337 kg/ha), indicating better phosphorus mobilization. Potassium availability was enhanced, with the highest recorded value (216.39 kg/ha) in the 100% RDF + Nano-Zn treatment, while	Singh, P. P., Priyam, A., Singh, J., & Gupta, N. (2023). Biologically synthesised urea-based nanomaterial shows enhanced agronomic benefits in maize and rice crops during Kharif season. Scientia Horticulturae, 315, 111988.
47	International	Research	Nano Zinc & Nano Copper	Lentil behavior following foliar nano particle application: implications for plant growth and development	2025	Proceedings of the Indian National Science Academy	https://doi.org/10.1007/s43538-025-00453-8	Lentil	The study was designed to analyze the effect of foliar spray of nano particles (copper and zinc) as mono or combination with different doses with recommended dose of fertilizers (RDF) in lentil. The outcome showed that the 50% RDF + Nano Cu recorded significantly higher growth parameter such as plant height, root length, fresh weight of shoot, dry weight of shoot, fresh weight of root, dry weight of root and number of branches per plant. Yield attributes and yield was also recorded maximum in 50% RDF + Nano Cu which was statistically at par with 50% RDF + Nano Zn + Nano Cu, resulting in achieving higher net return and maximum	Thakur, A., Paliwal, A., Kumar, A., & Kumar, P. (2025). Lentil behavior following foliar nano particle application: implications for plant growth and development. Proceedings of the Indian National Science Academy, 1-6.

Nano Fertilizers Publications

SN	International /National	Paper Type	Product	Title	Publication Year	Journal	DOI Number	Crop	Abstract	Reference
48	International	Review	Nanofertilizers	Comprehensive analysis of nano-fertilizers in Indian agriculture- A review	2024	Plant Science Today	https://doi.org/10.14719/ps.t.4226	Not Applicable	This is a comprehensive review of studies of nano-fertilizers for their efficacy in stimulating plant growth, facilitating higher nutrient uptake and thus enhancing overall crop yield and productivity. The intricate insights into the mechanisms through which nano-fertilizers ensure sustained nutrient release, optimize nutrient absorption and augment nutrient utilization efficiency, have been reviewed. Several scientific studies indicate the potential of nanotechnology to enhance crop performance in terms of better crop growth and higher productivity. Regarding the economic implications of adopting nano-fertilizers, several findings indicate that nano-fertilizers could offer cost advantages over conventional fertilizers, potentially alleviating the government's subsidy burden and reducing import expenses on huge quantities of major commercial fertilizers.	Verma, S., Yadav, D., Verma, V., Siddiqui, M., Kumar, R., Kumar, S., Maurya, S. K. & Kumar, M. (2024). Study on Nano-Zn, Inorganic, and Organic Nutrient Management Practices and Their Impact on Nutrient Availability in Kharif Maize (Zea mays L.). Journal of Scientific Research and Reports, 30(10), 229-235.
49	International	Research	Nano Urea	Effect of nano urea on greenhouse gas emissions in transplanted rice (Oryza sativa L.) ecosystems	2024	Plant Science Today	https://doi.org/10.14719/ps.t.5813	Rice	The results indicated that applying 75 kg nitrogen/ha (50% of the recommended dose) as basal through conventional urea, along with 3 nano urea foliar sprays at 20, 40 and 60 days after transplanting (T5), resulted in significantly lower methane and nitrous oxide emissions compared with 100% of the recommended nitrogen dose i.e. 150 kg nitrogen/ha applied through conventional urea, with 25% used at basal, active tillering, panicle initiation and heading stage (T1) and 150 kg nitrogen/ha i.e. 100% recommended dose of nitrogen applied through conventional urea, with 50% as basal and 2 top dressings of 25% of the recommended dose of nitrogen (RDN) each at active tillering	Anushka, A. S., Nunavath, U., Kumar, G. S., Kanade, A. K., Pradeepkumar, S., & Sritharan, N. (2024). Effect of nano urea on greenhouse gas emissions in transplanted rice (Oryza sativa L.) ecosystems. Plant Science Today, 11, 5813.
50	International	Research	Nano Urea	Strategic Switching from Conventional Urea to Nano-Urea for Sustaining the Rice–Wheat Cropping System	2024	Plants	https://doi.org/10.3390/plants13243523	Rice, Wheat	Results showed that 33% nitrogen replacement with nano-nitrogen (T3) outperformed conventional urea (T2) in physiological traits and achieved higher grain yields (3789 kg/ha for rice and 4206 kg/ha for wheat) compared to T2 (3737 kg/ha for rice and 4183 kg/ha for wheat with 100% urea). Although T4 and T5 showed statistically similar yields, they were lower than T2 and T3 for rice, while 50%, 66%, and 100% replacements reduced wheat yield by 2.49%, 8.39%, and 41.26%, respectively, compared to T2. Key enzymes of N metabolism decreased with higher nano-nitrogen substitution. This study concludes that nano-nitrogen is an effective strategy to enhance growth, balancing productivity and environmental sustainability.	Kumar, A., Sheoran, P., Devi, S., Kumar, N., Malik, K., Rani, M., Kumar, A., Dhansu, P., Kaushik, S., Bhardwaj, A. K., Mann, A. & Yadav, R. K. (2024). Strategic Switching from Conventional Urea to Nano-Urea for Sustaining the Rice–Wheat Cropping System. Plants, 13(24), 3523.
51	International	Review	Nano Urea	Nano-nutrients can blunt effects of soil contamination, boost crop yields	2024	NA	https://phys.org/news/2024-10-nano-nutrients-blunteffects-soil.html	Not Applicable	The bulk fertilizers that you may be more familiar with are made up of large particles, which aren't as readily absorbed by the crop. Nanomaterials are more effective than conventional fertilizers at mitigating the harmful effects of polluted soil (by 38.3%), can enhance crop yields (by 22.8%) and the nutritional value of those crops (by 30%), as well as combat plant stress (by 21.6%) due to metal and metalloid pollution. Nanomaterials also help increase soil enzymes and organic carbon, both of which help	Nano-nutrients can blunt effects of soil contamination, boost crop yields (2024, October 15) retrieved 16 October 2024 from https://phys.org/news/2024-10-nano-nutrients-blunteffects-soil.html
52	International	Research	Nano Urea & Nano DAP	Molecular modeling and docking investigations of gum Arabic glycosides and glycoproteins stabilized nano-urea & Nano-DAP liquid fertilizer's foliar surface interactions and its impact through metabolite profiling in maize plant (Zea mays L.).	2025	International Journal of Biological Macromolecules	https://doi.org/10.1016/j.ijbiomac.2025.145357	Maize	Present study aims to determine the molecular interactions responsible for the formation and stability of the liquid nano-fertilizers stabilized by the encapsulation of Gum Arabic glycosides and glycoproteins in aqueous medium through molecular modeling and molecular dynamics which is crucial for their large scale commercial production. Besides, the molecular docking interactions occur through foliar spray of liquid nano-urea at the interface of plant leaf's wax coating and cell membrane are revealed to comprehend the mode of entry of nano-fertilizers into plant leaves. In addition to the computational approach, experimental trials are also conducted to study the effect of foliar application of nano urea liquid fertilizers on maize (Zea mays L.) and their metabolite profiling obtained through GC–MS instrumental analysis are reported. The mechanism of expression of growth invigorating metabolites such as citric acid, phthalic acid and palmitic acid etc., caused by the foliar treatment of nano-urea liquid fertilizers and the metabolite's binding activation with maize growth stimulating target	Jayamugundha, P., Sharmila, D. J. S., Kannan, P., Lakshmanan, A., Sivashankari, L., Prasanthrajan, M., Harish, S., Praveenkumar, K. & Jayakanthan, M. (2025). Molecular modeling and docking investigations of gum Arabic glycosides and glycoproteins stabilized nano-urea & Nano-DAP liquid fertilizer's foliar surface interactions and its impact through metabolite profiling in maize plant (Zea mays L.). International Journal of Biological

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53	International	Research	Nano Urea, Nano DAP & Nano Potassium	Assessing the Impact of Mineral Based Nutrient Sources and Nano-Fertilizers on Root Growth, Soil Health, and Nutrient Availability in Wheat Crop	2023	Research Square	https://doi.org/10.21203/rs.3.rs-3444003/v1	Wheat	IMBP was multnutrient source. Root length density, root surface area density and root dry weight were 20-21%, 14- 19% and 25-29% higher, respectively with IMBP and nano fertilizers compared to recommended P & K, and with RDN. Significant population of bacteria (73-74 ×105 CFU/g soil), and actinomycetes (49.7-49.8 ×105 CFU/g soil), dehydrogenase, alkaline and acid phosphatase activity were reported with IMBP + nanofertilizers. Higher values of microbial population, and enzyme activity were reported with basal + 2 sprays of nano urea, at par with RDN. Available nitrogen (245-246 kg/ ha), sulphur (16.3 kg/ ha) and silicon (71-78 mg/ kg soil) after harvest recorded significantly higher values for the IMBP, whereas phosphorus and potassium was comparatively higher where their nano forms were applied.	Jayara, A. S., Kumar, R., Singh, A. V., Shukla, A., Pandey, P., Bhatt, M., Singh, N. K & Singh, A. P. (2023). Assessing the impact of mineral based nutrient sources and nano-fertilizers on root growth, soil health, and nutrient availability in wheat crop.
54	International	Research	Nano Urea & Nano Zinc	Evaluation of the Effect of Foliar Nano Nitrogen and Zinc on Chlorophyll (SPAD) and Qualitative Traits of Green Chilli in Comparison with Urea and ZnSO4	2023	Journal of Environment and Climate Change	10.9734/IJEC/C/2023/v13i92464	Chilli	The results revealed that chilli quality parameters significantly varied with applying nano N and Zn compared to the control. Among the treatments, application of RDN (125%) and foliar nano N (0.4%) and Zn (0.4%) at 30 and 45 DAT registered significantly higher chlorophyll, oleoresin, ascorbic acid and TSS. T3 reported significantly superior ascorbic acid and oleoresin content to 14.94 per cent and 22.10 per cent over control.	Kanavi, G. J., Sunil, C., Salimath, S. B., Mallikarjuna, H. B., Kadam, P. V., & Jeevan, H. R. (2023). Evaluation of the effect of foliar nano nitrogen and zinc on Chlorophyll (SPAD) and qualitative traits of green chilli in comparison with urea and ZnSO4. International Journal of Environment and Climate Change, 13(9), 2317-22.
55	International	Research	Nano Urea & Nano Zinc	Nano Nutrient Foliar Application: Impacts on Yield, Quality, and Nutrient Efficiency in Dryland Finger Millet	2025	Journal of Plant Nutrition and Soil Science	https://doi.org/10.1002/jpln.202300294	Finger millet	Foliar application of nano-N and nano-Zn along with 100% RDN + recommended PK in finger millet significantly enhanced the growth, yield, and nutrient utilization efficiency of finger millet. Application of 100% RDF + foliar spray of nano-N and nano-Zn recorded the highest grain yield (3486 kg ha ⁻¹) and straw yield (4810 kg ha ⁻¹), significantly outperforming treatments with conventional fertilizers alone. This treatment also improved the qualitative attributes such as the number of ear heads (6.53), length of ear heads (6.95 cm), and dryweight per plant (146.80 g). Similar was the trend with antioxidant enzymes, namely, catalase and peroxidase activity, proximate composition of finger millet grain with higher crude protein (8.88%), crude fiber (2.90%), ash (2.40%), and fat (1.46%). Moreover, this treatment also recorded the highest economic returns, with gross returns of Rs. 108,192 ha ⁻¹ and net returns of Rs. 79,579 ha ⁻¹ , making it the most effective and beneficial strategy for finger millet cultivation under	Huq, Z. U., Vasanthi, B. G., Mudalagiriappa, Sneha, M. A., Harish, M. C., Devaraja, K., & Singh, V. K. (2025). Nano nutrient foliar application: impacts on yield, quality, and nutrient efficiency in dryland finger millet. Journal of Plant Nutrition and Soil Science, 188(2), 350-365.
56	National	Research	Nano Urea	The effect of foliar application of Nano Urea (Liquid), on Rice (Oryza Sativa)	2021	Journal of Andaman Science Association	Not Applicable	Rice	The total cost for nano urea spray was higher than NPK addition but recorded 12-16% higher yield over RDF addition resulting in additional monetary benefits (Rs. 7,937 to 10,082). Further, the increased efficiency of nano urea resulted in saving of nitrogen fertiliser to the extent of 25-34%.	Velmurugan, A., Subramanil, T., Bommayasamy, N., Ramakrishna, M. K., & Swaranam, T. P. (2021). The effect of foliar application of nano urea (liquid) on rice (Oryza sativa L.). J. Andaman Sci. Assoc , 26 , 76-81.
57	National	Review	Nanofertilizers	Innovative Specialty and Nano Fertilizers for Enhancing Nutrient Use Efficiency in the Dryland Agro-ecosystems	2022	Indian Journal of Fertilisers	Indian Journal of Fertilisers 18 (11) : 652, November, 2022	Not Applicable	New and efficient plant growth promoting agri-inputs like seaweed extract-based biostimulants, organically chelated products, protein hydrolysates, amino acid-based products, humates, organo-mineral fertilizers, 100% water soluble fertilizers (powder & liquid) and nano fertilizers (powder & liquid) for foliar and fertigation have brought in a paradigm shift in the principles of crop nutrition and enhancing crop productivity with minimum environment footprints.	Tarunendu Singh, Yogendra Kumar, Naveen Kumar Sain and Sri Laxmi Innovative Specialty and Nano Fertilizers for Enhancing Nutrient Use Efficiency in the Dryland Agro-ecosystems Indian Journal of Fertilisers 18 (11) : 12-22

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58	National	Research	Nano Urea, Nano Zinc & Nano Copper	Effect of Foliar Application of Different Nanofertilizers on Performance of Rainfed Maize in Southern Telangana	2022	First International Conference Reimagining Rainfed Agro-ecosystems: Challenges & Opportunities	ISBN: 978-93-80883-67-0	Maize	Application of recommended NPK + foliar spray of nano-urea + nano-Zn + nano-Cu being on par with recommended NPK + foliar spray of nano-urea + nano-Zn recorded significantly higher grain yield (3308 kg/ha) compared to other treatments.	Rama Rao, C.A., Srinivasa Rao, M., Suvana S, Shanker, A.K., Pratibha, G., Rejani, R., Kundu, S., Santosh, H.B., Asewar, B.V., Rohit, J., Rao, K.V. & Singh, V.K. 2022. First International Conference in 'Reimagining Rainfed Agro-ecosystems: Challenges and Opportunities'. Extended Summaries. Indian Society of Dryland Agriculture, Hyderabad. p. 915.
59	National	Research	Nano Urea	Studies On Comparison Of Nano-Urea And Prilled Urea For Enhancing Maize (Zea Mays) Growth And Productivity	2023	Indian Journal Of Agricultural Sciences	https://doi.org/10.56093/ijas.v94i3.143292	Maize	An experiment was conducted during the rainy (kharif) season of 2022–23 at the ICAR-Indian Agricultural Research Institute, Hazaribagh, Jharkhand to assess how well nanourea performs in maize under different field conditions and investigate its compatibility with other N sources. Results showed that root weight (fresh and dry), partial factor productivity (N, P2O5 and K2O), N concentration (grain and stover), grain yield, biological yield and harvest index of maize were all significantly affected by the application of various N rates and nano-fertilizers. The grain yield of maize was comparable to the yield obtained under RDF and 75% of the recommended N + two nano-urea sprays. These findings indicate that the concurrent use of these nano-fertilizers has the potential to reduce N fertilization by as much as 25%. Furthermore, the results highlight the prospect of augmenting biological yield of maize by incorporating 2 nano-urea sprays alongside the prescribed N quantity from prilled urea, as well as full applications of P2O5 and K2O.	Rawat, S., SINGH, R. K., Singh, P., Upadhyay, P. K., Shekhawat, K., Sangwan, S., ... & Shukla, R. (2024). Studies on comparison of nano-urea and prilled urea for enhancing maize (Zea mays) growth and productivity. <i>The Indian Journal of Agricultural Sciences</i> , 94 (3).
60	National	Review	Nano Urea	Nano Urea: A Promising Approach For Sustainable Agriculture In India	2023	Recent Advances and Technological Interventions in Agriculture, Organic Farming, Agri-Ecosystem and Agri-Marketing	ISBN: 978-93-5747-294-4	Not Applicable	Agriculture is one of the major sectors of the Indian economy, but it is facing challenges such as soil degradation, water scarcity, and environmental pollution. The use of traditional chemical fertilizers has led to adverse effects on the environment and human health. Nano urea is a promising alternative to conventional urea, which can significantly reduce the amount of nitrogen required for crop growth. This review provides an overview of nano urea technology and its potential benefits for sustainable agriculture in India.	Akshay Pareek, Amit Kumar, Sumit Bhardwaj, Amit Verma Nano Urea: A Promising Approach For Sustainable Agriculture In India In Recent Advances and Technological Interventions in Agriculture, Organic Farming, Agri-Ecosystem and Agri-Marketing (pp. 95-104). Iterative International Publishers
61	National	Parliament Report	Nano Urea	39th Standing Committee On Chemicals & Fertilizers (2022-23) 17th Lok Sabha Ministry Of Chemicals And Fertilizers Nano-Fertilizers For Sustainable Crop Production And Maintaining Soil	2023	Presented To Lok Sabha On 19.12.2023	Not Applicable	Not Applicable	Summary of research and Field Trials on Nano Fertilizers, Progressive journey of Nano Fertilizers, promotion and application of Nano Urea	Standing Committee on Chemicals & Fertilizers. (2023, March 21). Thirty-ninth report of the Standing Committee on Chemicals & Fertilizers (2022–23) (17th Lok Sabha): Nano-Fertilizers for sustainable crop production and maintaining soil health. Lok Sabha Secretariat.

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62	National	Parliament Report	Nano Urea	47th Standing Committee On Chemicals And Fertilizers (2023-24) (17th Lok Sabha) Action Taken By The Government On The Observations/Recommendations Of The Committee Contained In Their 39th Report	2023	Presented To Lok Sabha On 21.03.2023	Not Applicable	Not Applicable	Analysis by the Government on the Recommendations contained in the Thirty-Ninth Report (17th Lok Sabha) of the Standing Committee on Chemicals and Fertilizers on 'Nano-fertilizers for sustainable crop production and maintaining soil health' of the Ministry of Chemicals and Fertilizers	Government of India. (2023). <i>47th Standing Committee on Chemicals and Fertilizers (2023–24) (17th Lok Sabha): Action taken by the Government on the observations/recommendations of the Committee contained in their 39th report</i> . Lok Sabha Secretariat.
63	National	Internal Paper	Nano Urea	IFFCO Nano Urea Insights & Impacts	2023	Dr. K. S. Subramanian, Professor and Former Director of Research Centre for Agricultural Nanotechnology, TNAU,	Not Applicable	Maize	Nano urea sprayed maize plants exhibited higher N content in eight points while urea sprayed ones registered higher values in only 4 points. This indicates the unique advantage of Nano urea spray in maintenance of higher N which is critical for plant productivity. Higher enzyme activities of GS, soluble proteins and chlorophyll content were detected at the first hour of sampling. On the other hand, at the 24th hour, NR, NiR, soluble protein and chlorophyll content were higher in nano-urea sprayed leaves.	Not Applicable
64	National	Review	Nanofertilizers	Nano-fertilizers: An Effective Way to Alleviate Biotic and Abiotic Stresses in Agriculture	2023	Indian Journal of Fertilisers	Indian Journal of Fertilisers 19 (8) : 768-784, August, 2023	Not Applicable	Nano-fertilizers (NFs) induce plant resistance against stress factors by strengthening the physical barrier, improving plant photosynthesis, activating defensive enzyme activity, increasing anti-stress compounds, and activating the expression of defence-related genes. NFs have proven ability to combat nutrient deficiencies, promote stress tolerance, and improve the yield and quality of crops. The current review highlights the potential impact of Nano-fertilizers in alleviating biotic and abiotic stresses in agriculture.	Yogendra Kumar, Nano-fertilizers: An Effective Way to Alleviate Biotic and Abiotic Stresses in Agriculture Indian Journal of Fertilisers 19 (8) : 768-784
65	National	Review	Nano Urea	Know How The Effect Of The Small Quantity Of Nano Urea Is Comparable With The High Quantity Of Conventional Urea	2024	Agri-India TODAY	ISSN : 2583-0910	Not Applicable	Sustainable agriculture demands minimal use of agrochemicals. Nano-fertilizers offer sustainable and profitable remedies to modern agriculture practices while restricting the use of chemical fertilizers by offering several advantages, such as improved efficiency, reduced waste, and increased nutrient uptake by plants. These smart fertilizers have significantly contributed towards efficient and eco-friendly approaches in crop productivity, nutrient penetration and soil fertility. The results of the on-station and on-farm IFFCO Nano urea trials clearly indicated the possibility of reduction in the doses of nitrogen to the extent of 25 to 50% in different crops under varying agro-ecological conditions.	K.N. Tiwari Know How The Effect Of The Small Quantity Of Nano Urea Is Comparable With The High Quantity Of Conventional Urea Agri-India TODAY Volume 4(03)91-103
66	National	ICAR Technology Data Repository	Nano Urea	Nano Urea (liquid) for reducing the application of conventional Urea and increasing ginger productivity	2024	KRISHI: Technology Collections Developed by ICAR Institutes	Not Applicable	Ginger	Foliar application of nano urea @ 0.4 % (two sprays at the active growth period of the ginger crop, 90 & 120 DAP) along with 50% of the RDF N as soil application is recommended for higher N use efficiency and rhizome yield.	Srinivasan V. (2023). Nano urea for increasing turmeric productivity and reducing the conventional urea requirement. ICAR Data Repository. e-ISSN 2582-8223. Retrieved from https://krishi.icar.gov.in/ScreenReader.jsp

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67	International	Research	Nano DAP	Combining Seed Dressing And Foliar Applications Of Phosphorus Fertilizer Can Give Similar Crop Growth And Yield Benefits To Soil Applications Together With Greater Recovery Rates	2020	Frontiers In Agronomy	10.3389/fagro.2020.605655	Wheat	Radioisotopic labeling showed that the application of foliar P in the presence of photosynthetic light substantially increased both P-uptake into the leaf and P-mobilization within the plant, especially when an adjuvant was used. When compared with soil application of inorganic P buried into the rooting zone, a combination of a 3 µmol seed dressing and three successive 46.3 µmol plant ⁻¹ foliar applications were far more efficient at providing P fertilization benefits in P-limiting conditions. We conclude that a combination of seed dressing and foliar applications of P is potentially a better alternative to conventional soil-based application, offering greater efficiency in use of applied P both in terms of P-uptake rate and grain yield.	Talboys, P. J., Healey, J. R., Withers, P. J., Roose, T., Edwards, A. C., Pavinato, P. S., & Jones, D. L. (2020). Combining seed dressing and foliar applications of phosphorus fertilizer can give similar crop growth and yield benefits to soil applications together with greater recovery rates. <i>Frontiers in Agronomy</i> , 2, 605655.
68	International	Research	Nano DAP	Performance Of Nano Dap Under Rice Wheat Cropping System In Vertisol Of Chhattisgarh, India	2023	International Journal Of Environment And Climate Change	10.9734/IJEC/C/2023/v13i9/2521	Wheat	In rice the results of soil microbial biomass carbon showed that higher values were recorded in treatments with 100 % P through DAP. Results of fungus reveals that 100 % and 75 % P through DAP obtained significantly higher soil fungus colony count. The results of total bacteria showed that 100 %, 75 % P through DAP and T4 + Root Dipping @ 5 ml /L + Foliar Spray @ 2 and 4 ml/ L at 30 DAT with Nano DAP obtained significantly higher soil total bacteria. The results of PSB reveals that 50% P through DAP and treatments in combination with 50% P through DAP and Nano-DAP obtained significantly higher phosphorus solubilizing bacteria.	Sahu, D., Banwasi, R., Shrivastava, L. K., Chowdhury, T., Jatav, G., & Kumar, H. (2023). Performance of Nano-DAP under Rice-Wheat Cropping System in Vertisol of Chhattisgarh, India. <i>International Journal of Environment and Climate Change</i> , 13(9), 2864-2875.
69	International	Research	Nano Urea & Nano DAP	Influence Of Super Nano Urea And Nano Dap On Growth Parameters Of Rice Fallow Cotton Under High Density Planting System	2023	International Journal Of Plant & Soil Science	10.9734/IJPS/S/2023/v35i1/93602	Rice	Based on the experimental results, it is concluded T10 i.e., reduced application of basal nitrogen and phosphorus (50% RDN&P + 100% K) with super nano urea foliar spray @ 1% and nano DAP foliar spray @ 0.5% at 25 DAS and 45 DAS found to be the optimal dosage for increased growth parameters under high density planting system in rice fallow cotton.	Mahachandramuki, E., Thirukumaran, K., Karthikeyan, R., Sivakumar, R., Sellamuthu, K. M., & Prabukumar, G. (2023). Influence of Super Nano Urea and Nano DAP on Growth Parameters of Rice Fallow Cotton under High Density Planting System. <i>International Journal of Plant & Soil Science</i> , 35(19), 711-716.
70	International	Research	Nano DAP	Nano-diammonium phosphate enhances grain yield by modulating gas exchange traits and nutrient use efficiency in rice	2024	Plant Science Today	https://doi.org/10.14719/ps.t.5508	Rice	Field trials included nine treatments, comprising 50% and 75% of the recommended dose of nitrogen and phosphorus (RDNP) and 100% of the recommended dose of fertilizers (RDF), and foliar application of conventional and nano-DAP. Foliar treatments were applied during the active tillering and panicle initiation stages. Among the treatments, 75% RDF and two foliar sprays of Nano-DAP performed better in terms of morpho-physiological parameters, particularly leaf area, dry matter production, photosynthetic rate, stomatal conductance, and number of productive tillers compared to 100% RDF. Furthermore, the NUE of Nano-DAP treatments was significantly higher, reflecting an improved ability of the rice plants to utilize the nanoform nutrients, resulting	Sweety, R. R. B., Boominathan, P., Senthil, A., Jegadeeswari, D., & Kumar, G. P. (2024). Nano-diammonium phosphate enhances grain yield by modulating gas exchange traits and nutrient use efficiency in rice. <i>Plant Science Today</i> , 11, 5508.
71	National	Research	Nano DAP & Nano Zinc	Effect Of Foliar Application Of Nanofertilizers On Performance Of Rainfed Maize In Southern Telangana	2023	National Conference on Agro - Ecology Based Agri - Food Transformation Systems	ISBN - 978-93-91872-21-2	Maize	Application of nano-DAP with N75P75KZn (2363 kg/ha) and N100P100KZn (2409 kg/ha) resulted in significantly higher grain yield compared to recommended dose of fertilizer without Nano-DAP (N100P100KZn) (2290 kg/ha).	Dr. N. Ravisankar Dr. A.K. Prusty Dr. Debashis Dutta Dr. Poonam Kashyap Dr Amrit Lal Meena Dr. M Shamim Dr. R.P. Mishra Dr. P.C. Jat Dr. Raghuvveer Singh Dr. P.C. Ghasal Dr. Jairam Choudhary Dr. Raghvendra K.J. Mr. Shivam Rathi 2023. National Conference On Agro-Ecology Based Agri-Food Transformation Systems,

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72	National	Research	Nano DAP	Significance and Response about IFFCO Nano DAP in Punjab	2024	Just Agriculture	Vol. 4 Issue-6, February 2024 (e-ISSN: 2582-8223)	Wheat	Results of Nano DAP on Wheat Crop is excellent increase germination and uniformity in g	Amrinder Singh and Gagandeep Singh, (2024). Significance and response about IFFCO Nano DAP in Punjab. Just Agriculture, 4(6), 245-254 https://www.justagriculture.in (e-ISSN: 2582-8223)