IMPACT OF NANO-DAP ON GROWTH AND DEVELOPMENT OF CABBAGE

ABSTRACT

The current study, "Impact of nano-DAP on growth and development of cabbage," was carried out in 2021–2022 at the Department of Horticulture's Experimental Farm at A.A.U., Jorhat. The treatments followed were T_1 (Untreated control), T_2 (100% RDF of N & K), T_3 (100% RDF of 130:80:80 kg/ha), T_4 (T_2 + ST with nano-DAP @ 5 ml/ltr), T_5 (T_2 + ST@ 10 ml/ltr), T_6 (T_2 + 1 FS of nano-DAP @ 6 ml/ltr at 25-30 DAT), T_7 (50 % P, 100% N & K + FS nano-DAP @ 2 ml/ltr at 25-30 DAT), T_8 (25% P, 100% N & K + FS nano-DAP @ 4 ml/ltr), T_9 (T_2 + ST @ 5 ml/ ltr + FS nano-DAP @ 6 ml/ltr), T_{10} (25% P, 100% N & K + ST @ 5 ml/ ltr + FS nano-DAP @ 4 ml/ltr), T_{11} (50% P, 100% N & K + ST @ 5 ml/ ltr + FS nano-DAP @ 2 ml/ltr), T_{12} (25% P, 50% N & 100% K + ST @ 5 ml/ ltr + FS nano-DAP @ 4 ml/ltr) and T_{13} (50% P, 50% N & 100% K + ST @ 5 ml/ ltr + FS nano-DAP @ 2 ml/ltr).

The results revealed that the maximum plant spread and number of non-wrapper leaves was observed in T_3 (17.12 cm) and (7.67) at 30 DAT whereas inT_3 (34.77 cm) and (16.83) at 60 DAT.The highest leaf area was recorded in T_3 (107.56 sqcm) at 30 DAT and at 60 DAT (226.54 sqcm), although at 30 DAT, the maximum leaf fresh weight was recorded in T_7 (4.40 g) although in T_3 (12.46 g) at 60 DAT. The maximum number of days (88.30 days) to harvest was taken by $T_{5.}$ Thus, the investigation suggests that nano-DAP can reduce the amount of inorganic fertiliser applied while maintaining the potency of the crop.

Keywords: Impact, growth, potency and nano-DAP.

1. INTRODUCTION

India represents the second-largest supplierof veggies worldwide after China, comprising an area and annual output of specifically 27.23 million tonnes and 329.86 million tonnes(DAC & FW, 2020-2021). The cruciferous crops, usually referred to as colecrops are members of the Brassicaceae family and have an ancestral relationship with Brassica oleracea L. var. sylvestris known as wild cabbage, cliff cabbage as well as colewort. The word "cole" is originated from the Latin term "caulis,"that implies "stem." The plant has become one of the the nation's principal veggies and usually grows in almost every region. Assam produces the most cabbage amongst the North Eastern regions, at roughly 640.13 tonnes, which is approximately 7.80% of the primary producing regions (85%).

Cabbage is a nutrient-rich food, comprising 400 I.U. of vitamin A, 27 mg of vitamin B1, 100 mg of vitamin C, 0.73% of calcium, 0.38% of phosphorus, 2.71% of potassium, 15 ppm of copper, 1.4% of protein, 5.3% of total carbohydrate, 0.2% of fat, and 92.4% of water per 100 g of palatable section (Brown and

Hutchison, 1949), however it contains significantly fewer amount of fat. In ancient times, cabbage was employed for its numerous medical benefits fighting ailments like gout, diarrhoea, gastrointestinal issues, and celiac disease. Because this plant contains indole-3-carbinol, it exhibits a cancer prevention action that protects towards cancer of the bowel. The extract of cabbage was additionally employed as a remedy for toxic mushrooms as well as a throat rinse for a sore throat. When salt is added pursuant to pressure to shredded cabbage leaves, a product that is fermented known as "sauerkraut" is created, and the resulting liquid is used to treat the scurvy condition.

Because of the rapid increase in world populations, we have to boost agricultural output on the same quantity of arable land. This shows that we must produce crops of superior quality if we want to increase availability while preserving the current resources. Since cabbage needs a lot of mineral compounds to grow and produce more, especially the three elements phosphorus, nitrogen, and potassium. Thereby, producers frequently apply these fertilisers indiscriminately in order to enhance output, which has an impact on both the cost of cultivation and the condition of the agricultural land. Several methods and approaches are being developed to decrease the overuse of fertilisers and boost the effectiveness of nutrient effectiveness. In this present instance, nanotechnology has demonstrated the ability to support sustainable agriculture through the manufacturing of fertiliser that is both effective and advantageous. By raising productivity, improving the nutritional value of food as well as preserving the nutrition equilibrium of the farmland. It is projected that this cutting-edge technology will increase the revenue generated by farms.

As an outcome of nanotechnology, nano fertilisers are distinct from conventional fertilisers in a number of aspects. According to Calabi-Floddy et al. (2018), smart fertilisers, sometimes referred to as nanofertilizers, are made using tiny particles that act as both nutrient transporters and carriers for controlled distribution. According to Rameshaiah et al. (2015) and Solanki et al. (2015), nano-fertilizers possess a bigger surface area, a higher capacity for incorporation, as well as regulated discharge in targeted locations. Nanoparticles are moved between cells in the roots by means of plasmodesmata.The delayed and purposeful delivery of components by the nano-fertilizer formulations keeps plants from inadvertently depleting essential elements through their uptake. As a result, the efficiency with which elements are utilised increases as the dietary surplus decreases. Nano-formulations necessitates less application than conventional fertilisers, which reduces run-off from the surface, leaching, or the and emissions of gases into the environment. Using nanofertilizers as an agent to promote more intelligent and environmental conscious agriculture is a tempting option due to its several essential qualities, such as their broad surface area, increased capacity for adsorption, more penetration potential, as well as appropriate controllable kinetics for providing nourishment at the envisioned regions alongside minimal loss (Janmohammadi et al. 2016). The most widely used phosphatic fertiliser is diammonium phosphate (DAP) due to its beneficial physical attributes as well as its elevated composition with N (18%) and P2O5 (46% of the overall constitution) so, it is generally favoured. Thus, applying this fertiliser in nano form is going to be quite advantageous. The Ministry of Chemicals and Fertilisers has therefore commanded the factories that produce fertiliser to speed up the development of nano-DAP while setting a goal to make the fertiliser accessible with the aim to lessen the reliance on imports in our nation in a year. Considering every one of these factors, investigations were done to evaluate the advantage of employing nano-DAP by evaluating the efficacy of nano-DAP on crop growth attributes at graded levels of fertilizer application.

2. MATERIALS AND METHODS

A field study entitled "Impact of nano-DAP on growth and development of cabbage" was conducted in the agro-climatic condition of Jorhat (Assam) at the Experimental Farm, Department of Horticulture, Assam Agricultural University during the year 2021-2022.The soil used for the experiment was clay loam. The crop "cabbage" was selected for this study. The seedlings were produced at the Experimental Farm. The cabbage cultivar "Angad" (Enza zaden) was taken for this study. Seeds were collected from the authorized dealer. The 13 therapies of nutrient administration that made up the experiment were arranged in a simple randomised manner. N, P and K were applied in the form of Urea, Single super phosphate (SSP), nano-DAP and Muriate of potash (MOP). The treatment combinations of the experiment were T_1 (Control (No Fertilizer), T_2 (100% RD of N & K (130:0:80 kg/ha)), T_3 (100 % RD of NPK (130:80:80 kg/ha)), T_4 (T_2 + Seedling root-dip treatment of n-DAP @ 5 ml/ltr), T_5 (T_2 + Seedling root-dip treatment of n-DAP @ 10 ml/ltr), T_6 (T_2 + 1 FS of n-DAP @ 6 ml/ltr at 25-30 DAT), T_7 (50% P, 100% N & K + FS of n-DAP @ 2 ml/ltr at 25-30 DAT), T_8 (25% P, 100% N & K + FS of n-DAP @ 4 ml/ltr at 25-30 DAT), T_9 (T_2 + ST @5 ml/ ltr + FS of n-DAP @ 6 ml/ltr at 25-30 DAT), T_{10} (25% P, 100% N & K + ST @ 5 ml/ ltr + FS of n-DAP @ 4 ml/ltr at 25-30 DAT), T_{11} (50% P, 100% N & K + ST @ 5ml/ ltr + FS of n-DAP @ 2 ml/ltr at 25-30 DAT), T_{12} (25% P, 50% N & 100% K + ST @ 5 ml/ ltr + FS of n-DAP @ 4 ml/ltr at 25-30 DAT) and T_{13} (50% P, 50 % N & 100% K + ST @ 5 ml/ ltr + FS of n-DAP @ 2 ml/ltr at 25-30 DAT).Studies were made between the findings made during the nano-DAP applications and the recommended dose of fertiliser. The observations for the plant growth parameters were taken as follows:

2.1 Plant Spread (cm)

Plant spread of the randomly chosen five plants was measured at 30 and 60 days after transplanting with the help of a measuring tape. The maximum distance in between the two opposite outer leaflets were surveyed crosswise in centimetres, and the mean was determined.

2.2. Number of non-wrapper leaves

At 30 and 60 days after transplanting five randomly selected plants were counted for the number of non-wrapper leaves, and a mean was calculated for each treatment.

2.3. Leaf area (sqcm)

After transplantation, the leaf area of each plant was measured at 30 and 60 days by placing the leaves in a leaf area meter. The readings were taken and averaged to get the leaf area.

2.4. Leaf fresh weight (g)

For measuring the leaf weight, fresh leaves of the randomly sampled five plants were collected. Fresh weight of the leaf samples were measured in an electric balance and then readings were taken and averaged to get the fresh leaf weight.

2.5. Leaf dry weight (g)

After being dried in hot air oven to get the weight of the dry leaves. Readings were taken and averaged to get the dry leaf weight.

2.6. Root fresh weight (g)

Fresh roots were collected from five random plants at 30 and 60 days, washed to remove the soil and were weighed in electronic balance. The root weights were averaged to get the fresh root weight.

2.7. Root dry weight (g)

The fresh roots which were collected earlier to get the fresh root weight were then dried in hot air oven until fully dried. The readings of the dry root were taken in electronic balance and averaged to get the dry root weight.

2.8. Days to harvest

The period of days from the transplantation date to the harvest date was calculated.

3. RESULTS AND DISCUSSION

3.1. Plant spread (cm)

Significant response in plant spread by the treatments is presented in Table No. 1. The results revealed that the maximum plant spread was observed in T_3 (17.12 cm) at 30 DAT and the minimum was observed in T_1 (8.60 cm). The maximum plant spread was observed in T_3 (34.77 cm) at 60 DAT and the minimum in T_1 (19.26 cm) . Treatments T_5, T_7, T_8, T_9, T_{10} and T_{11} were found to be statistically at par with T_3 at 30 DAT and T_7 & T_8 were statistically at par with T_3 at 60 DAT. Of the plants that were treated with nano-DAP, the highest plant spread was recorded in T_5 (16.47 cm) and T_7 (34.45 cm) at 30 & 60 DAT and the minimum plant spread was recorded in T_{12} (14.61 cm) and T_4 (25.56 cm) at 30 & 60 DAT. It is possible that the leaf application of nano-DAP aided in the crops' immediate uptake of N and P, leading to increased tissue differentiation, proliferation of cells, and elongation of cells. Analyses on cabbage conducted by Nath (2000) confirm this conclusion.

3.2. Number of non-wrapper leaves

The data on number of non-wrapper leaves presented in Table No. 1 showed significant differences among the treatments. At 30 & 60 DAT the maximum number of non-wrapper leaves (7.67 & 16.83) was recorded in T_3. The minimum number of non-wrapper leaves was recorded in T_2 (6.03) and T_1 (10.50) at 30 & 60 DAT, respectively. Treatment T_7 was found to be statistically at par with T_3 at 30 DAT while T_7, T_{11}, T_{12} and T_{13}were at par with T_3 at 60 DAT. Of the plants administered nano-DAP, the greatest no. of non-wrapper leaves was recorded in T_7 (7.60) at 30 DAT and the minimum was recorded in T_6 (5.23) at 30 DAT. At 60 DAT the maximum no. of non-wrapper leaves was recorded in T_{12} (17.43) and the minimum was recorded in T_6 (11.50). Treatments T_8 and T_{11} were found to be statistically at par with T_7 and treatments T_7 & T_{13} were found to be statistically at par with T_{12} at 30 & 60 DAT. The variations in the number of non-wrapper leaves might be due to the certainity that nutrient release efficiency supplied by different doses of fertilizers were not in a similar magnitude. Nath (2000), Devi and Singh (2012) also recorded similar observations in cabbage.

3.3. Leaf area (sqcm)

The results of the leaf area were significantlyimpacted by the treatments and are furnished in Table 1. The highest leaf area was recorded in T_3 (107.56 sqcm) at 30 DAT and at 60 DAT (226.54 sqcm) and the lowest was recorded in T_1 (17.27 sqcm) at 30 DAT and at 60 DAT T_1 (37.70sqcm). Amongst the crops that were treated with nano-DAP at 30 & 60 DAT the highest leaf area was recorded in T_7 (88.33 and 183.70 sqcm). The lowest leaf area was recorded in T_4 (27.40 sqcm) at 30 DAT and inT_4 (54.69 sq cm) at 60 DAT. The disparity among the leaf areas of different treatments might be due to the synergistic outcomes of discrete doses of fertilizers applied. Nitrogen has a significant influence on the morphological development of plants, favouring the growth of plants with larger leaf areas that are more effectively used in the production of heads. With higher nitrogen rates, the vegetative characteristics improved (Chaudhury *et al*., 2015).

3.4. Leaf fresh weight (g)

The data on leaf fresh weight presented in Table 1 showed a significant difference among the treatments. At 30 DAT, the maximum leaf fresh weight was recorded in T_7 (4.40 g),however, did not differ significantly from T_3, T_8, T_9 and T_{11}. At 60 DAT the leaf fresh weight was recorded maximum in T_3 (12.46 g) while the minimum leaf fresh weight was in T_1 (0.91 g) at 30 DAT and at 60 DAT (5.25 g). Amongst the nano-DAP treatments, the maximum leaf fresh weight at 30 & 60 DAT was recorded in T_7 (4.40 g) and T_{11} (10.61 g), respectively and the minimum weight at 30 & 60 DAT were recorded in T_4 (1.39 g) and (9.27 g). At 30 DAT T_8, T_9 and T_{11} were found to be statistically at par with T_7. At 60 DAT treatments T_6, T_7, 7_8 and T_9 were found to be statistically at par with T_{11}. The agronomic qualities of the produce were enhanced by higher levels of nitrogen (Chaudhury et al., 2015).

TABLE No. 1 Measurement of Plant Spread, Number of non-wrapper leaves, Leaf Area, and Leaf fresh weight

Treatments	Plant spread (cm) 30 DAT	Plant spread (cm) 60 DAT	Number of non-wrapper leaves 30 DAT	Number of non-wrapper leaves 60 DAT	Leaf area (sqcm) 30 DAT	Leaf area (sqcm) 60 DAT	Leaf fresh weight (g) 30 DAT	Leaf fresh weight (g) 60 DAT
T_1	8.60	19.26	6.40	10.50	17.27	37.70	0.91	5.25
T_2	13.11	21.85	6.03	11.50	18.97	44.03	1.16	7.81
T_3	17.12	34.77	7.67	16.83	107.56	226.54	4.13	12.46
T_4	15.04	25.56	6.43	12.40	27.40	54.69	1.39	9.27
T_5	16.47	28.45	5.70	14.97	27.88	58.41	1.41	9.41
T_6	15.41	26.20	5.23	11.50	37.94	63.41	1.77	9.93
T_7	16.36	34.45	7.60	16.77	88.33	183.70	4.40	10.50
T_8	16.20	32.46	7.37	15.27	78.95	158.81	4.07	10.17
T_9	15.60	26.59	6.50	14.60	63.70	127.81	3.88	9.84
T_{10}	15.35	29.42	6.23	15.03	55.68	111.07	2.98	9.72
T_{11}	16.39	32.01	7.33	15.80	65.83	130.57	4.03	10.61
T_{12}	14.61	30.16	6.40	17.43	57.96	113.56	3.28	9.61
T_{13}	14.70	32.00	6.63	16.97	62.95	115.03	3.44	9.64
SEd (±)	0.68	0.99	0.14	0.64	4.28	10.59	0.28	0.40
CD (5%)	1.40	2.05	0.28	1.32	8.85	21.86	0.57	0.82

ST: Seedling root-dip treatment FS: Foliar spray

3.5. Leaf dry weight (g)

A significant difference was found in leaf dry weight (Table No. 2). At 30 DAT, the maximum leaf dry weight was obtained in T_3(1.29 g) while the minimum was observed in T_2 (0.02 g). Application of 100% NPK 130:80:80 kg/ha (T_3) proved to be superior in leaf dry weight (4.98 g) among all the treatments at 60 DAT the minimum being in T_1 (0.91 g). Among the nano-DAP treated plants, the maximum leaf dry weight at 30 DAT was recorded in T_7 (0.95 g) and the minimum was in T_4 (0.06 g) while at 60 DAT the maximum leaf dry weight (4.11 g) was observed in T_9 (N & K 130:80 kg/ha + seedling root-dip @ 5 ml/ ltr + foliar spray of n-DAP @ 6 ml/ltr at 25-30 DAT) and the minimum (2.86 g) was observed in T_5 and T_{10}. At 30 DAT, treatments T_8, T_9, T_{11} and T_{13} were found to be statistically at par with T_7 and at 60 DAT, T_7 and T_8 were found to be statistically at par with T_9. The contrariety within the treatments might be due to the cumulative impact of different dose of fertilizer application.

3.6. Root fresh weight (g)

Data presented in Table No. 2 revealed that root fresh weight was significantly influenced by the treatments. At 30 DAT, the maximum root fresh weight was registered in T_3 (7.27 g) and the minimum was observed in T_1 (3.44 g). At 60 DAT, the maximum root fresh weight was observed in T_3 (23.75 g) and the minimum was observed in T_1 (13.93 g). At 30 DAT, treatments T_7 and T_8 were found to be statistically at par with T_3 and at 60 DAT, T_7 was found to be statistically at par with T_3. Amongst the nano-DAP treated plants, the maximum root fresh weight was obtained in T_7 (7.24 g) and the minimum was recorded in T_4 (3.74 g) at 30 DAT. At 60 DAT, the maximum root fresh weight was observed in T_7 (22.69 g) but did not differ significantly from T_8, T_9, T_{10} and T_{11} and the minimum was observed in T_4 (19.30 g). Variability in root penetration and growth may have been mediated by the cumulative impact of different fertiliser dosages that improved the physical properties and soil composition, leading to the difference in root weight. Nath (2000) reported comparable results with cabbage.

3.7. Root dry weight (g)

Data presented in Table No. 2reveales that root dry weight was significantly influenced by the treatments. At 30 DAT, the maximum root dry weight was observed in T_7 (2.25 g) and the minimum was observed in T_4 (0.72 g). At 60 DAT, the maximum root dry weight was again registered by T_7 (8.32 g) while the minimum (3.40 g) was found in untreated control plots (T_1). Within the nano-DAP treated plants, the minimum root dry weight was observed in T_4 (4.10 g) at 60 DAT. The difference in root dry weight may result from the synergistic impact of different fertiliser formulations that improved physical attributes and soil composition.

3.8. Days to harvest (days)

The data presented in Table No. 2 reveal that the treatments had a significant influence on days to harvest. The maximum number of days (88.30 days) to harvest was taken by T_5 (N & K 130:80 kg/ha + seedling root treatment @ 10 ml/ltr nano-DAP) but was statistically comparable with T_3, T_{12} & T_{13} while the minimum was observed in T_1 (77.30 days). Amongst the nano-DAP treatments, the minimum days was recorded in T_8 (80.30 days). The variations could be because of the fact that since nano-DAP also includes N, maturation is delayed by high N levels, extending vegetative growth at the expense of maturation (Nath, 2000). The graphical representation of the data is presented in FIG. 1.

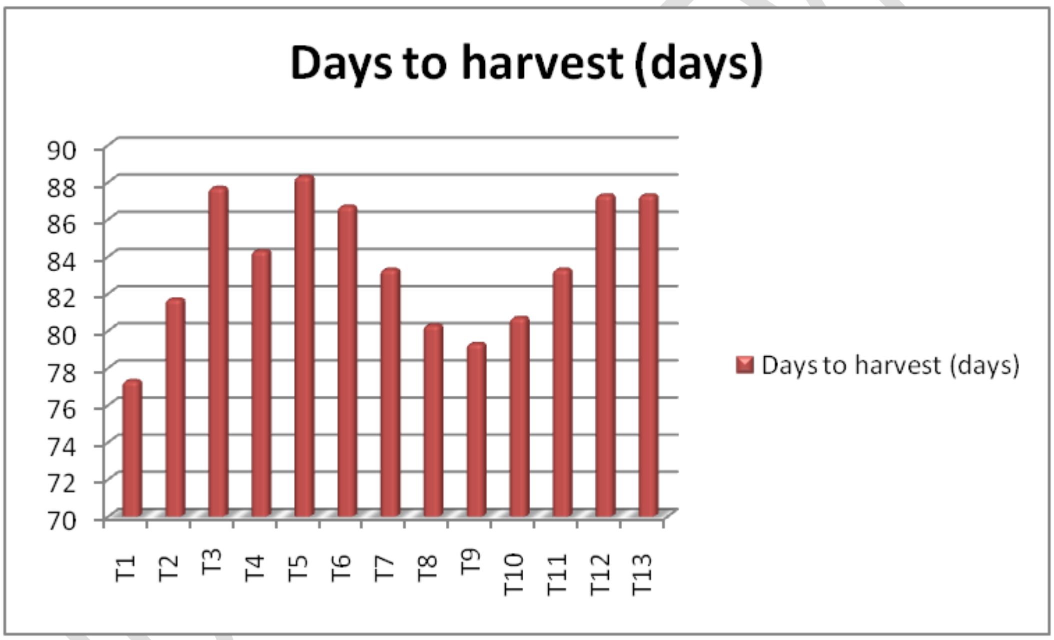

FIG 1. DAYS TO HARVEST (DAYS)

TABLE No. 2 Measurement of Leaf dry weight, Root fresh weight, Root dry weight, and Harvesting days

Treatments	Leaf dry weight (g) 30 DAT	Leaf dry weight (g) 60 DAT	Root fresh weight (g) 30 DAT	Root fresh weight (g) 30 DAT	Root dry weight (g) 30 DAT	Root dry weight (g) 60 DAT	Days to harvest (days)
T_1	0.05	0.91	3.44	13.93	0.91	3.40	77.30
T_2	0.02	2.45	4.13	18.17	0.92	5.15	81.70
T_3	1.29	4.98	7.27	23.75	2.11	7.03	87.70
T_4	0.06	2.88	3.74	19.30	0.72	4.10	84.30
T_5	0.07	2.86	5.57	19.36	1.19	4.27	88.30
T_6	0.08	2.91	5.77	20.00	1.10	5.15	86.70
T_7	0.95	3.94	7.24	22.69	2.25	8.32	83.30
T_8	0.83	3.98	7.15	22.04	1.73	6.63	80.30
T_9	0.84	4.11	5.54	21.85	1.09	4.53	79.30
T_{10}	0.75	2.86	5.72	22.11	1.13	4.56	80.70
T_{11}	0.93	3.66	6.48	22.12	1.26	5.65	83.30
T_{12}	0.56	3.06	5.66	20.25	1.04	4.11	87.30
T_{13}	0.81	3.30	5.80	19.98	1.22	4.40	87.30
SEd (±)	0.08	0.21	0.19	0.64	0.12	0.33	0.56

CD (5%)	0.16	0.43	0.40	1.32	0.25	0.68	1.15

ST: Seedling root-dip treatment FS: Foliar spray

4. CONCLUSION

The current study clearly shows that applying nano-DAP at different graded levels both as a spray on the foliage and seedling root dip therapy was highly successful in improving the growth characteristics of cabbage heads. Because nano-DAP significantly reduces the amount of applications. Thus, in terms of usage volume as well as cost, it can be utilised as a competitively priced and environmentally beneficial substitute for traditional inorganic fertilisers.

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