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Effect of Different sources of nitrogen on growth, yield and quality of strawberry (*Fragaria x ananassa* Duch.) cv. chandler under poly house condition

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Abstract
A field investigation entitled "Effect of Different Sources of Nitrogen on Growth, Yield and Quality of Strawberry (*Fragaria x ananassa* Duch.) cv. Chandler under Poly House Condition" was conducted at Horticulture Research Farm, Central Agricultural University, Andro, Imphal, Manipur, during October 2019 to February 2020. The experiment was laid out in Randomized Block Design (RBD) with three replications under 8 different treatments. Results of the experiment revealed that the application of 100% N from urea (T_3) registered significant values for plant height (14.77 cm), plant spread (25.06 cm), number of leaves per plant (18.87), number of runners per plant (6.81). fresh weight of plant (29.93 g), dry weight of plant (5.88 g), number of fruits per plant (6.58) and fruit yield (7.98 t/ha). Least days taken to 1st flowering (50 days after transplanting) and least titratable acidity (0.64%) was exhibited by 100% N from vermicompost (T_4). T_4 also recorded significant results in yield attributes like single fruit weight (12.58 g) and fruit diameter (2.82 cm) and quality attributes like specific gravity (1.86 g/cm^3), juice% (83.07%), total soluble solids (8.86°Brix) and vitamin C (66.97 mg/100g).

Keywords: Strawberry, poly house, urea, vermicompost, significant

Introduction
Strawberry (*Fragaria x ananassa* Duch.) is a temperate, non-climateric fruit belonging to family Rosaceae. The cultivated varieties are octoploid (2n=8x=56) in nature and has been derived from hybridization of two North American species, *Fragraria chiloensis* and *Fragraria verginiana*. It is one of the most popular soft fruits cultivated in plains as well in hills. Strawberry fruits are soft, highly perishable and attractive with distinct pleasant aroma and delicate flavour.

Strawberry is well known for its rich nutrient contents especially vitamin C. The fruit contains 89.9% moisture, 0.7 g protein, 8.4 g carbohydrate, 0.5 g fat, 59 mg/100g vitamin C. Strawberry also has high pectin, available in the form of calcium pectate, which serves as an excellent ingredient for jelly-making (Mitra, 1991) [7].

Nitrogen is one of the important macronutrients that affect growth and development of strawberry. It is important for plant growth, runner production and fruit bud formation. It is the most imperative element for proper growth and development of strawberry which significantly increases and enhances the yield and its quality by playing a vital role in biochemical and physiological functions of strawberry (Leghari *et al.*, 2016) [5]. Besides, it is present in many other plant compounds which are of great physiological importance in metabolism such as chlorophyll, nucleotides, alkaloids, enzymes, hormones, vitamins etc. During growth period, deficiency of nitrogen causes small leaves and may turn from green to light green or yellow. In older leaves, the leaf stalk reddens and the leaf blades become brilliant red. There is reduction in fruit size and the calyx around the fruit becomes reddish.

Farm Yard Manure (FYM) plays an important role in increasing strawberry yield by enhancing physico-chemical properties of soil. On an average, well decomposed FYM contains 0.5% N, 0.2% P_2O_5 and 0.5% K_2O. Organic manures like FYM when applied to soil improve soil physical properties, pH, Water-holding capacity and add essential nutrients to the soil, thus increasing the availability of nutrients and its absorption by plant.

Vermicompost is a product of biodegradation and stabilization of organic materials by interaction between earthworms and micro-organisms. It is rich in essential plant nutrients and provides excellent effect on overall plant growth that encourages the growth of new shoots or leaves and improves the quality and shelf life of the produce. Vermicompost contains 1.75-2.5% N,.1, 1.25-2% P_2O_5, 1.5-2.5% K_2O and have C:N ratio 12-15.

There is little inorganic nitrogen in soil and most of it obtained by the conversion of organic forms (Sathe *et al*., 2008) [9]. Therefore, in order to supplement the nitrogen requirement by the crop, organic manures alongside inorganic nitrogen sources has been incorporated with the view to maintain the soil health and maintain the ecological balance. Keeping in view the important roles played by nitrogen, the investigation focused on use of different sources of nitrogen to obtain higher yield of fruits and better quality of fruits was done.

Materials and Methods

The field experiment was carried out during October 2019 to March 2020 at the Horticulture Research Farm, Central Agricultural University, Andro, Imphal, Manipur. The layout of the experiment was Randomized Block Design (RBD) with three replications under 8 different treatments of T_0 - control, T_1 - 100% N from FYM, T_2 - 100% N from vermicompost, T_3 - 100% N from urea, T_4 - 50% N from vermicompost + 50% N from urea, T_5 - 75% N from vermicompost + 25% N from urea, T_6 - 50% N from FYM + 50% N from urea and T_7 - 75% N from FYM + 25% N from urea.

Strawberry saplings having 2-3 fully open leaves, that were raised in poly bags were transplanted on raised beds at 30 cm x 30 cm spacing and mulched with black polythene. The quantity of manures and fertilizer applied were as per the recommended dose (100:60:140 kg NPK/ha) of strawberry crop. The calculated FYM and vermicompost was applied at the time of field preparation which was done 15 days ahead of the transplantation of saplings. The required quantity of nitrogen supplied through urea was applied in 3 splits, half as basal and the remaining half in two equal split doses; half dose was applied after 30 days of transplanting and the remaining dose after 45 days of transplanting.

Results and Discussion

Growth parameters

Effect of different sources of nitrogen on plant height, plant spread, number of leaves per plant, number of runners per plant, days to first flowering, Fresh weight of plant and dry weight of plant is illustrated in Table 1. The results obtained revealed that growth parameters were significantly influenced by application of nitrogen. Maximum plant height (14.77 cm) and plant spread (25.06 cm) were recorded with the application of 100% N from urea (T_3) while minimum plant height (10.55 cm) and plant spread (20.33 cm) were recorded in control (T_0). Increase in plant height might be because of nitrogen supplying through urea being readily available to the soil, which might have supplied sufficient nitrogen to the strawberry plant throughout the growth stages. Increase in plant spread might be due to available of nitrogen as per the requirement at the growth stages of strawberry plant, which might have enhance nitrogen uptake that had an impact on the plant spread. The present findings are in line with Khutate *et al*. (2005) [4]. The growth parameters like number of leaves and number of runners were also responded positively to different sources of nitrogen. It was observed that plants supplied with 100% N from urea (T_3) recorded the maximum values for number of leaves (18.87) and number of runners (6.81) while the minimum values for number of leaves (12.58) and number of runners (3.51) were recorded in control (T_0). In case of number of runners, 100% N from urea (T_3) (6.81) remained at par with 50% N from vermicompost + 50% N from urea (T_4) (6.47). Increase in number of leaves might be due to application of urea which might have supplied sufficient nitrogen during the early growth period of strawberry plant as the release of nitrogen through urea is quick resulting in increased number of leaves. Increase in number of runners might be due to increase in other growth parameters like plant height and number of leaves, which might have accumulated more photosynthates resulting in increase number of runners. The present findings are in conformity with the results of Medhe *et al*. (2010) [6]. The experiment revealed that application of vermicompost significantly increased initiation of flowers. Minimum days to 1st flowering (50.00 days after transplanting) was observed in 100% N from vermicompost (T_2), which remained at par with 75% N from vermicompost + 25% N from urea (T_5) (50.71 days after transplanting) while maximum days to 1st flowering (56.12 days after transplanting) was observed in control (T_0). It might be due to slow release of nitrogen through vermicompost. The present finding is in line with Adhikari *et al*. (2016) [1]. The results obtained in the investigation revealed that maximum fresh plant weight (29.93 g) and dry plant weight (5.88 g) were recorded in 100% N from urea (T_3) while minimum values for fresh plant weight (25.63 g) and dry plant weight (1.29 g) were recorded in control (T_0). Positive effects of urea to all the growth parameters might have significantly influenced both fresh plant weight and dry plant weight. The results are supported by Tei *et al*. (2002) [13].

Yield parameters

Effect of different sources of nitrogen on fruit weight, fruit diameter, number of fruits per plant and fruit yield is illustrated in Table 2. The observed data revealed that yield parameters were significantly influenced by different sources of nitrogen. Among the different sources of nitrogen, 100% N from vermicompost (T_2) exhibited maximum single fruit weight (12.58 g) and fruit diameter (2.82 cm) while control (T_0) showed the least for the said yield parameters i.e. 7.37 g for fruit weight and 1.69 cm for fruit diameter. Increase in these yield parameters might be due to greater availability of macro nutrients and growth hormones produced by vermicompost resulting in better fillings of fruits due to easy uptake of nutrients that much have lead to better protein synthesis and carbohydrate synthesis. The present findings are in line with Singh *et al*. (1970) [10] and Khan *et al*. (2019) [13]. The data observed indicated that maximum number of fruits (6.58) was recorded in 100% N from urea (T_3) while minimum number of fruits (4.25) was recorded in control (T_0). Increase in number of fruits might be due to increase in number of leaves, which must have increased photosynthetic activity resulting in production of more carbohydrates. This can be supported with the findings of Singh *et al*. (2012) [13]. The results obtained in the investigation revealed that maximum fruit yield (7.98 t/ha) was recorded in 100% N from urea (T_3) while minimum fruit yield (3.06 t/ha) was

recorded in control (T_0). This might be due to maximum number of fruits acquired under this treatment. Similar finding was reported by Umar *et al*. (2009) [14].

Quality parameters

Effect of different sources of nitrogen on specific gravity, juice%, total soluble solids, titratable acidity and vitamin C is illustrated in Table 3. The analysis revealed that quality parameters were significantly influenced by different sources of nitrogen. The data observed indicated that maximum specify gravity (1.86 g/cm^3) was recorded in 100% N from vermicompost (T_2) while minimum specific gravity (1.09 g/cm^3) was recorded in control (T_0). Maximum specific gravity might be due to maximum fruit weight obtained under this treatment. The finding is in line with Rayees *et al*. (2015) [8]. The result obtained in the analysis revealed that maximum fruit juice content (83.07%) was recorded in 100% N from vermicompost (T_2) while minimum fruit juice content (72.44%) was recorded in control (T_0). Maximum fruit juice content under this treatment might be due to application of vermicompost which might have enhanced fruit development and cell thickening and elongation, thereby enhanced ripening with better succulent fruits. The finding is supported by Ghaderi and Talaie (2008) [2]. The observed data revealed that maximum total soluble solids (8.86°Brix) was recorded in 100% N from vermicompost (T_2) while minimum total soluble solids (6.70°Brix) was recorded in control (T_0). However, 100% N from vermicompost (T_2) (8.86°Brix) remained at par with 100% N from FYM (T_1) (8.70°Brix). Maximum total soluble solids under this treatment might be due to stimulation of the functioning of number of enzymes by sufficient supply of nitrogen from organic manures, which might have affected the physiological process. The finding is in conformity with Rayees *et al*. (2015) [8]. The data observed indicated that least titratable acidity (0.64%) was recorded in 100% N from vermicompost (T_2) while highest titratable acidity (0.73%) was recorded in control (T_0). Least titratable acidity might be due to highest total soluble solids obtained under this treatment. The result is in close conformity with Umar *et al*. (2009) [14]. The finding of the analysis indicated that maximum vitamin C (66.97 mg/100g) was recorded in 100% N from vermicompost (T_2) while minimum vitamin C (60.72 mg/100g) was recorded in control (T_0). However, T_2 remained at par with 100% N from FYM (T_1) (65.9 mg/100g). Application of organic manures might have made adequate availability of nutrients during maturity stage as organic manures take longer time for decomposition and slow release of nitrogen, resulting in increase of vitamin C content of fruits under this treatment. The finding is in line with Singh *et al*. (2008) [11].

Table 1: Growth parameters of strawberry as influenced by different sources of nitrogen

Treatment	Plant height (cm)	Plant spread (cm)	No. of leaves per plant	No. of runners per plant	Days to 1st flowering	Fresh weight of plant (g)	Dry weight of plant (g)
T_0	10.55	20.33	12.58	3.51	56.12	25.63	1.29
T_1	12.20	21.24	13.60	4.42	54.67	27.29	3.33
T_2	12.62	21.87	14.11	4.68	50.00	27.62	3.56
T_3	14.77	25.06	18.87	6.81	51.97	29.93	5.88
T_4	14.31	23.75	18.11	6.47	51.61	29.44	5.49
T_5	13.20	22.60	15.66	5.58	50.71	28.44	4.42
T_6	13.91	23.09	17.02	6.06	52.78	28.90	4.88
T_7	12.95	22.27	15.13	5.08	53.78	27.73	3.91
S.Ed. (±)	0.14	0.32	0.25	0.30	0.40	0.21	0.13
CD (0.05)	0.29	0.68	0.53	0.63	0.86	0.45	0.28

Table 2: Yield parameters of strawberry as influenced by different sources of nitrogen

Treatment	Fruit weight (g)	Fruit diameter (cm)	No. of fruits per plant	Fruit yield (t/ha)
T_0	7.37	1.69	4.25	3.06
T_1	9.53	2.11	4.67	4.31
T_2	12.58	2.82	5.00	6.13
T_3	12.22	2.64	6.58	7.98
T_4	11.79	2.56	6.02	7.11
T_5	10.87	2.26	5.31	5.55
T_6	11.52	2.45	5.64	6.26
T_7	8.65	1.90	5.08	4.26
S.Ed (±)	0.15	0.07	0.22	0.22
CD (0.05)	0.33	0.16	0.47	0.48

Table 3: Quality parameters of strawberry as influenced by different sources of nitrogen

Treatment	Specific gravity (g/cm^3)	Juice (%)	Total soluble solids (°Brix)	Treatable Acidity (%)	Vitamin C (mg/100g)
T_0	1.09	72.44	6.70	0.73	60.72
T_1	1.38	77.57	8.70	0.65	65.91
T_2	1.86	83.07	8.86	0.64	66.97
T_3	1.79	81.66	7.40	0.71	61.79
T_4	1.73	80.32	7.91	0.68	63.66
T_5	1.52	78.85	8.36	0.66	65.56
T_6	1.65	79.94	7.53	0.69	62.56
T_7	1.18	76.51	8.11	0.67	64.34
S.Ed (±)	0.03	0.54	0.17	0.006	0.51
CD (0.05)	0.06	1.15	0.37	0.014	1.09

Conclusion

The following conclusion may be drawn from the investigation that among the different sources of nitrogen, 100% N from urea (T_3) gave better plant growth and fruit yield of strawberry and 100% N from vermicompost (T_2) gave better quality of fruits.

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