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Analysis of Biochemical Parameters and APTI of Neem (*Azadirachta indica*) and Sajina (*Moringa oleifera*) Plants during Monsoon and Winter Seasons in Purulia Town, WB, India

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A survey was undertaken to evaluate the biochemical parameters like chlorophyll, carbohydrate, ascorbic acid, APTI of Neem *(Azadirachta indica)* and Sajina *(Moringa oleifera)* plants and sample leaves were collected during two different seasons like monsoon of 2019 and winter of 2020, from ten different sites of Purulia town like Nistarini College premises, Deshbandhu Road near Raghabpur more, Station para (near Maheswari lodge), Railway station and surrounding areas, Bus stand to Taxi stand, Gopal More, Zilla School More, Bhatbandh, Goshala More, Bongabari. All of these areas are either in the vicinity of heavily vehicle burdened roads or railway station. Neem *(Azadirachta indica)* and Sajina *(Moringa oleifera)* plants were selected as these plants are very commonly found in this area. Carbohydrate in Neem leaves were significantly higher during monsoon at all sites excluding Station Para, Gopal More and Bhatbandh where no significant differences were noticed. Carbohydrate levels were reduced during winter in Nistarini College Premises, Railway Station, Bus Stand to Taxi Stand, Bhatbandh and Goshala More but reverse results were observed during winter in leaves samples collected from Station Para and Zilla School More. Air Pollution Tolerance Index (APTI) indicates the tolerance capacity of plants species to air pollution and can be calculated to categorize sensitive, intermediate and tolerant species. Lowest and highest APTI value for Neem leaves during monsoon were recorded from Gopal More (13.88) and Goshala More (17.84) respectively while during winter season lowest APTI value of same species was observed in Deshbandhu Road (5.96) but highest value was experienced from Zilla School More (20.56). In case of Sajina leaves, during monsoon, maximum APTI was noticed in Nistarini College premises (15.97) and minimum value was recorded from Goshala More (12.72). In winter season lowest APTI was noticed in Bus stand to Taxi stand area (10.12) and highest value was from Station para near Maheswari Lodge (16.59).

Key words: APTI, Air Pollution, Green belt, Carbohydrate

1. Introduction

Air pollution now-a-days is one of the major global problems producing huge stress to health and environment [1]. Urbanization, increasing mining activities, expansion of agro-fields, road extension as well as transportation, construction activities, booming industrialisation and related other anthropogenic activities poses serious threat to air quality. Around 80% population residing in urban air quality is being exposed to emissions which exceed the standards guided by WHO [2]. A gradual increase in the global population in the modern decades have been observed from 7.4 billion in 2016 to 7.7 billion in 2019, 7.8 billion in 2020 to 7.9 billion in 2021. The world population is predicted to reach 9.9 billion by 2050 [3]. 800000 annual deaths as a result of urban air pollution have been reported by Researchers [4]. The gradual degradation of air quality urgently requires suitable techniques or policies to curb air pollution [5]. Vegetation covers or plants can be used as natural, cost effective way to reduce the problem of air pollution. Plants are susceptible to air pollutants. Deposition of pollutant particulates on soil indirectly affects plant growth. Au-

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tomobile based pollutants deposit on leaves, block the stomata and eventually affect transpiration. These depositions obstruct absorption and eventually decrease photosynthesis and affect the growth of plants and their productivity [3]. Air Pollution Tolerance Index indicates the tolerance capacity of plant species to air pollution and APTI can be estimated by using the data of pH, ascorbic acid, total chlorophyll and relative water content. APTI of plants can be evaluated to identify sensitive, intermediate and tolerant species. Plants having APTI value ≤ 11 are considered as sensitive while plants having APTI value which falls in the range 12–16 is classified as intermediate plant while APTI value ≥ 17 is known as tolerant plant. The sensitive plant species can be used as bio indicator to detect the level of air pollution while tolerant species can be widely used to create green belt to combat with the difficulties of air pollution [6]. Panda *et al.*, 2018 observed that air pollution tolerance index is a natural feature of trees to reduce air pollution nuisance. The trees having higher APTI values are tolerant towards air pollution and these plants can be used to reduce the burden of air pollution whereas the trees having low APTI values can be used to detect the rate and intensity of air pollution [7]. Plants of Perumalmalai Hill situated at Salem district were surveyed to recognize the tolerance level to air pollution in the month of Feb, 2013. *Nerium oleander* was identified as intermediate tolerant species (APTI value 16.65) while *ficus benghalensis*, *Psidium guajava*, *Skothodea campanulata*, *Opunitaficus indica* (APTI 15.92, 15.41, 9.92, 9.74 respectively) was recognized as sensitive species [8]. APTI value of 69 plant species of herbs, shrubs, trees of urban industrial belt Lahartara of Varanasi were analysed and it was found that C. roseus etc. were observed as tolerant and D. sissoo, L. chinensis, C. carandus and C. rottleri were observed as sensitive to air pollution [9]. Present study was conducted with an aim to assess biochemical parameters like pH, RWC, ascorbic acid, carbohydrate and chlorophyll content as well as Air Pollution Tolerance Index (APTI) of Neem *(Azadirachta indica)* and Sajina *(Moringa oleifera)* leaves collected from ten different places of Purulia town of W.B., India.

2. Materials and Methods

Purulia is situated in the central-west of West Bengal and normally known as the drought prone area. Sub-tropical type of climate of Purulia is characterized by high level of evaporation with little precipitation. It is placed just north of the Kasai River [10]. DMS longitude and latitude of Purulia Town area are $23°20'32.1252''$ N and $86°21'46.2204''$ E respectively. The sample collection sites in Purulia town were Nistarini College premises, Deshbandhu Road near Raghabpur more, Station para (near Maheswari lodge), Railway Station and surrounding areas; Bus Stand to Taxi Stand, Gopal More, Goshala More, Bhatbandh, Zilla School More, Bongabari (in between Bharat Super Cement Factory and Metallurgical Factory). All of these areas are either in the vicinity of heavily vehicle burdened roads or railway station. Neem *(Azadirachta indica)* and Sajina *(Moringa oleifera)* plants were selected as these plants are very commonly found in this area. After collecting the leaves of Neem *(Azadirachta indica)* and Sajina *(Moringa oleifera)* plants from the sampling sites, these were brought into the laboratory and then pH [11], RWC [12], chlorophyll [13], carbohydrate [14] and ascorbic acid [15] were estimated as early as possible. Chlorophyll, carbohydrate and ascorbic acid were estimated from the plant materials using centrifuge machine and spectrophotometer. Data of analytical results of biochemical parameters and statistical calculations i.e., *t*-tests (SPSS 13) are presented by the respective graphs and tables. Air Pollution Tolerance Index (APTI) indicates the tolerance capacity of plants species to air pollution and can be calculated to categorize sensitive, intermediate and tolerant species and can be calculated as follows [16]:

$$APTI = [A(T + P)] + R/10$$

A = Ascorbic acid content of leaf (mg/g), T = Total chlorophyll content of leaf (mg/g), P = Leaf Extract pH, R = % Relative Water Content

3. Results and Discussion

Analytical results of biochemical parameters of Neem *(Azadirachta indica)* as well as Sajina *(Moringa oleifera)* are presented by the Fig. 1 to 5 and Fig. 6 to 10 respectively. No significant differences in pH level in Neem leaves were observed at Zilla School more and Bongabari in between two seasons. pH level of leaves samples collected from Nistarini College campus as well as Bongabari area were significantly higher during monsoon whereas pH level of same were significantly enhanced during winter in remaining six spots (Fig. 1). No significant differences in RWC of Neem leaves between two seasons were observed in case of samples collected from Station Para and Railway Station but significant reduction in RWC were observed during winter in the spots like Nistarini College Premises, D. B. Road, Bus Stand to Taxi Stand, Gopal More, Goshala More, Bhatbandh and Bongabari while RWC increased during winter in case of Zilla School More only (Fig. 2). Chlorophyll levels in Neem leaves were significantly higher during monsoon period in most of the sample collection sites except Railway Station, Bhatbandh and Goshala More where no significant differences were observed (Fig. 3). Carbohydrate in Neem leaves were significantly higher during monsoon at all sites excluding Station Para, Gopal More and Bhatbandh where no significant differences were noticed (Fig. 4). Ascorbic acid level in Neem leaves were significantly elevated in winter season at the spots like Railway Station, Gopal More, Zilla School More, Bhatbandh and Bongabari (Fig. 5).

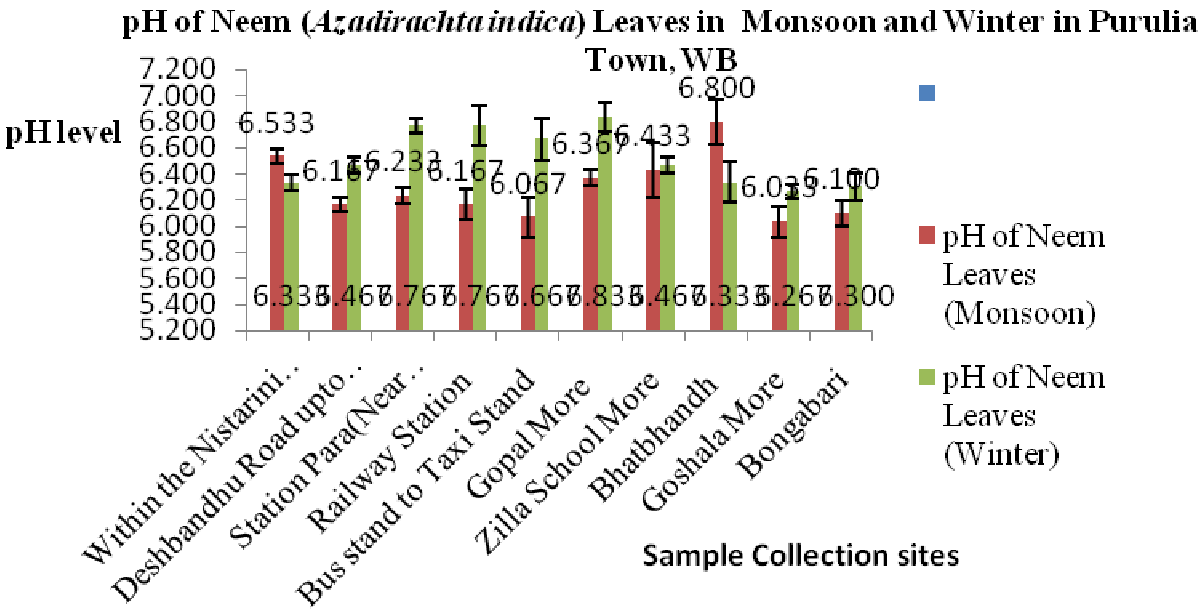

Fig. 1. pH of Neem leaves in monsoon and winter

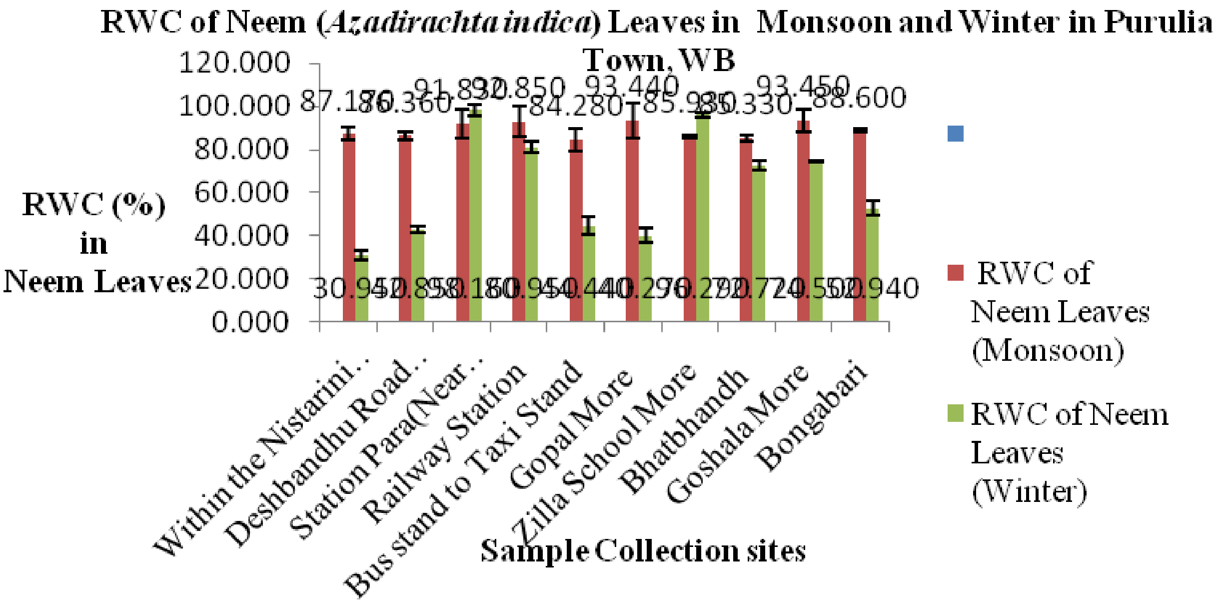

Fig. 2. RWC of Neem leaves in monsoon and winter

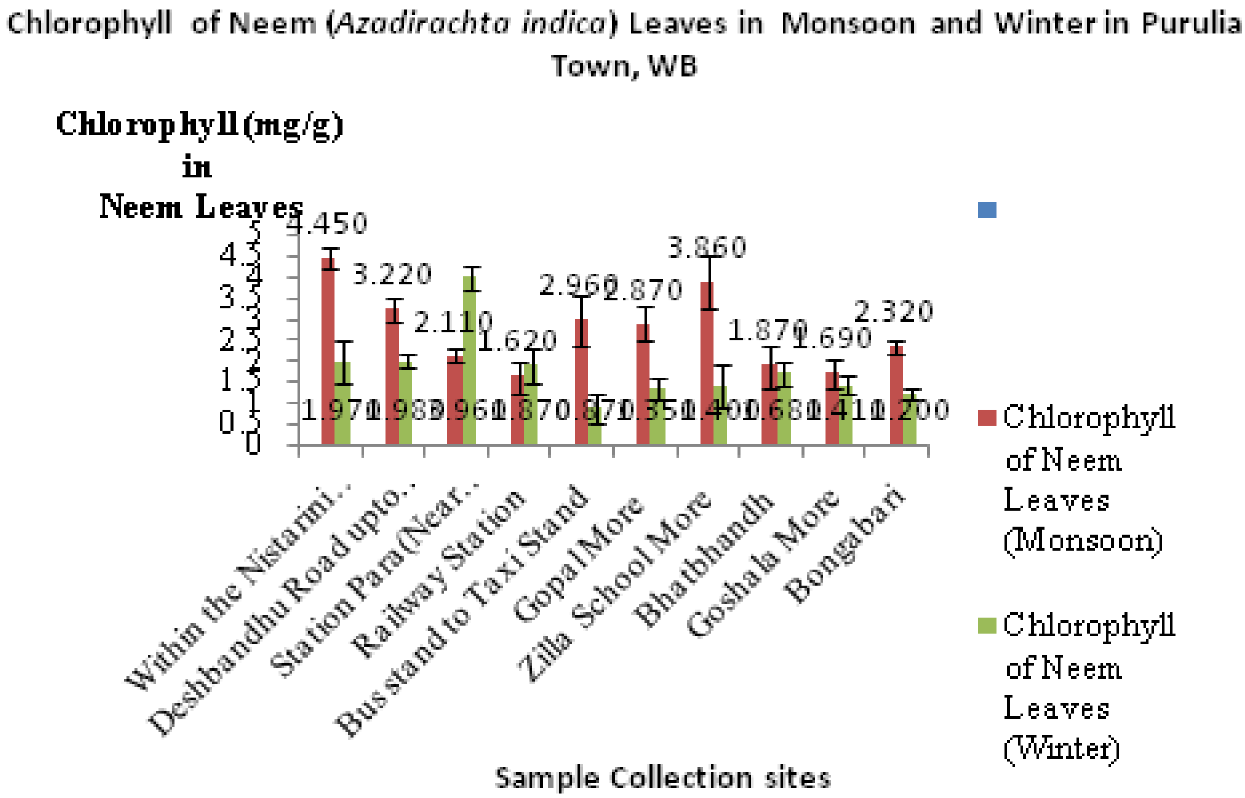

Fig. 3. Chlorophyll of Neem leaves in monsoon and winter

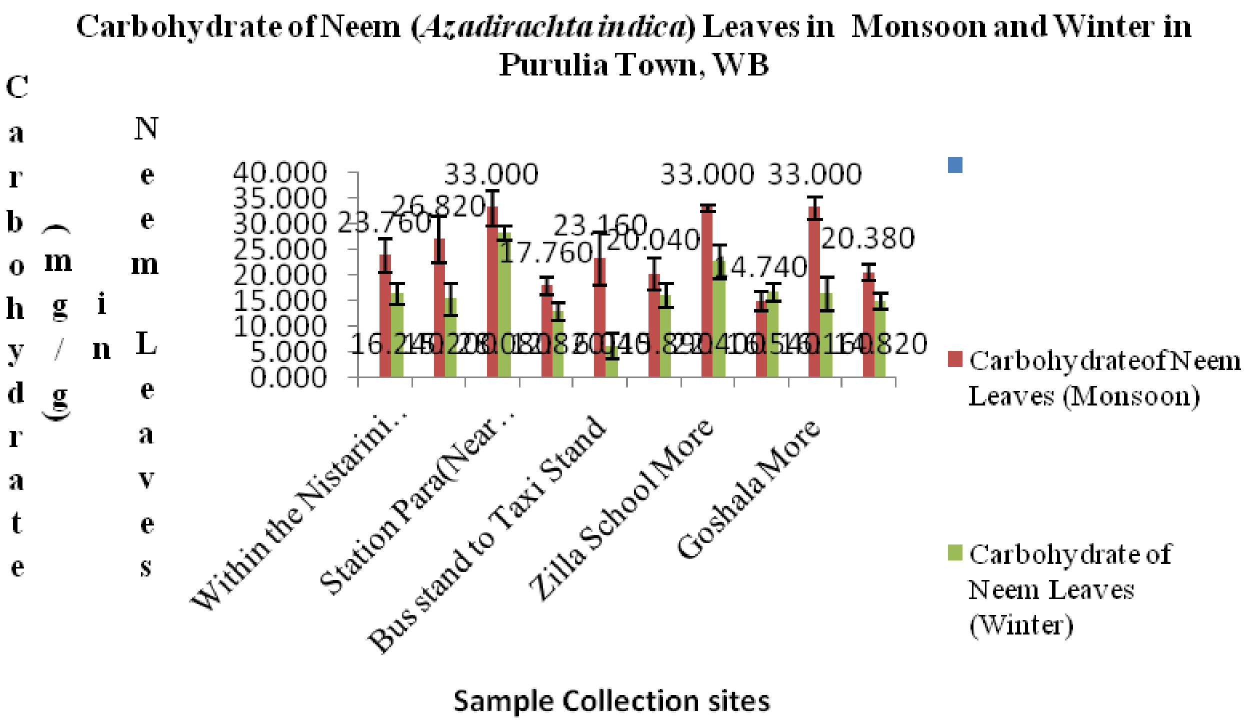

Fig. 4. Carbohydrate of Neem leaves in monsoon and winter

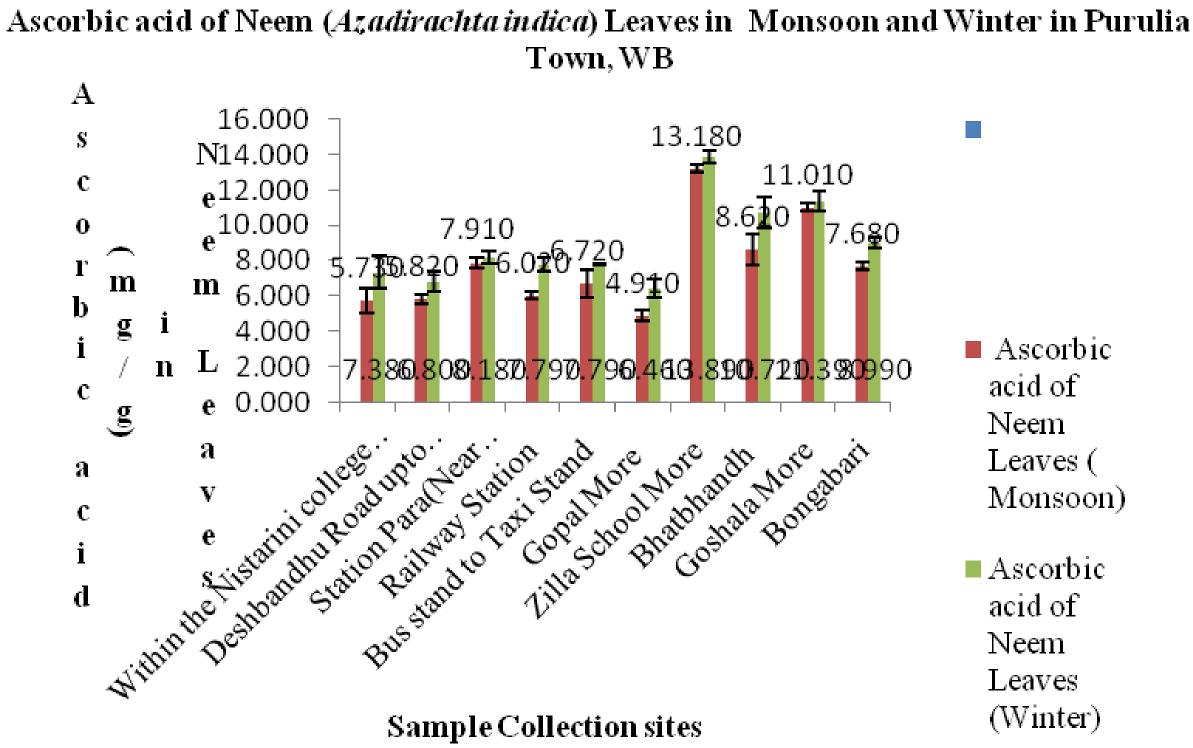

Fig. 5. Ascorbic acid of Neem leaves in monsoon and winter

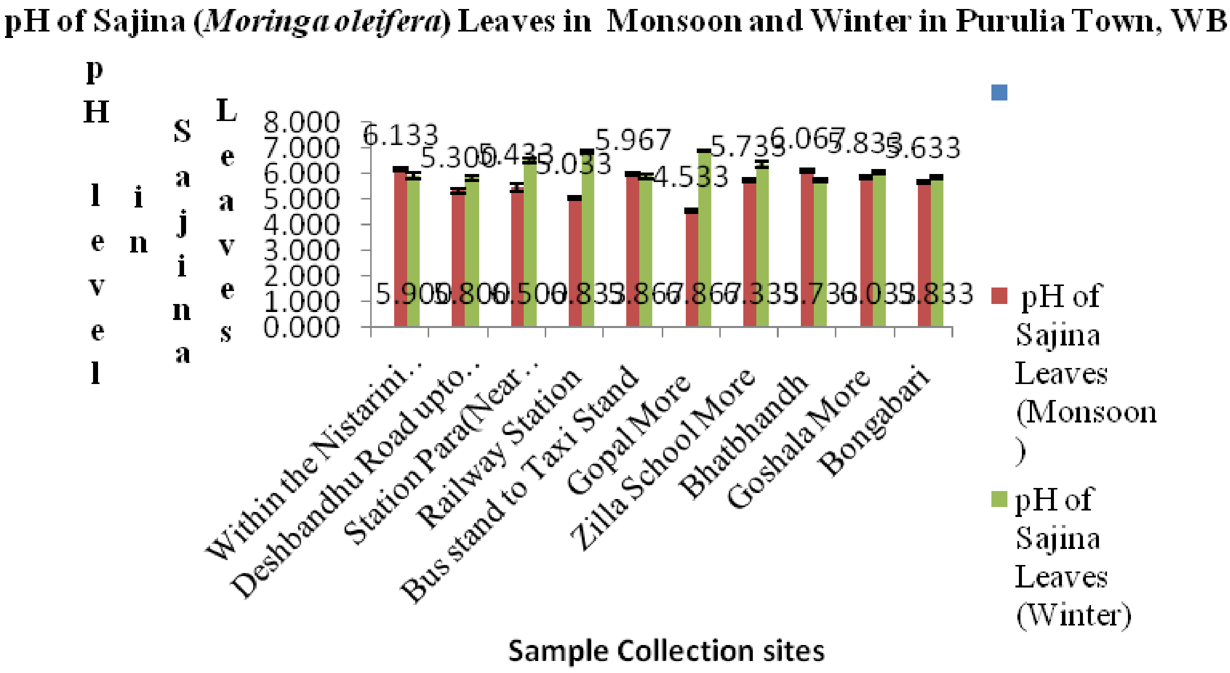

Fig. 6. pH of Sajina leaves in monsoon and winter

pH of Sajina leaves were significantly reduced in winter in the Nistarini College campus as well as in Bhatbandh area but elevated level of pH was observed in winter in Sajina leaves samples collected from other spots except the bus stand to taxi stand area only, where no significant differences were noticed in between two seasons (Fig. 6). No significant differences were found in RWC level in Sajina leaves between two seasons in the places like Nistarini College Campus and Station para (surrounding area of Maheswari Lodge). RWC increased during winter in the samples collected from Zilla School More and Goshala More whereas samples collected from the rest of the sites showed increased level of RWC in monsoon time (Fig. 7). Chlorophyll level of Sajina leaves were significantly reduced in winter in the areas like Bus Stand to Taxi Stand, Gopal More, Bhatbandh, Goshala More and Bongabari (Fig. 8). Carbohydrate levels were reduced during winter in Nistarini College Premises, Railway Station, Bus Stand to Taxi Stand, Bhatbandh and Goshala More but reverse results were observed during winter in leaves samples collected from Station Para and Zilla School More (Fig. 9). Significant increases in Ascorbic acid level were noticed in Sajina leaves during winter in Station Para near Maheswari Lodge, Bus Stand to Taxi Stand, Zilla School More and Bhatbandh (Fig. 10). Air pollutants for instance O_3 and NO_x, influence the metabolic activity of plant leaves and hamper net carbon fixation by the plant shade. Air pollutants

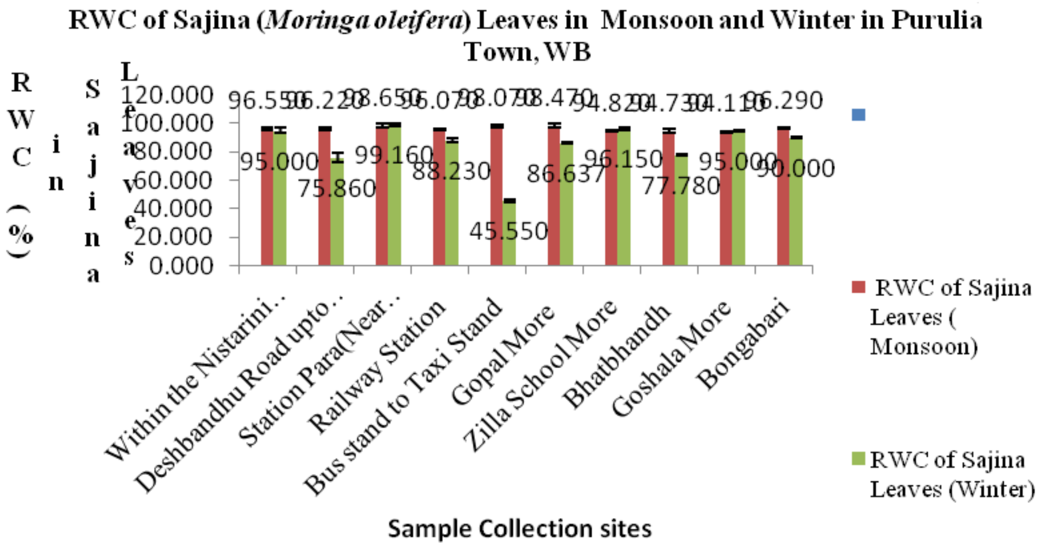

Fig. 7. RWC of Sajina leaves in monsoon and winter

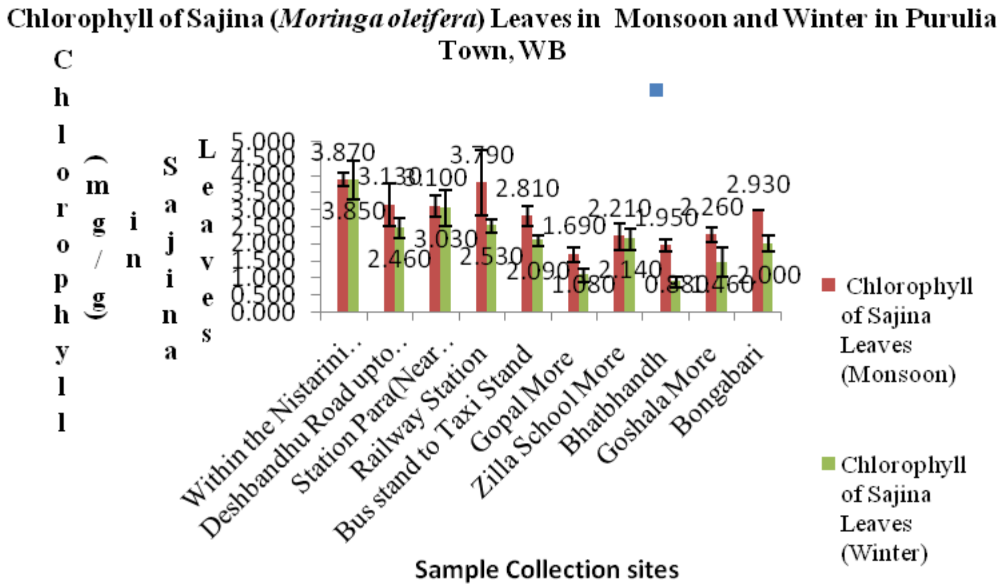

Fig. 8. Chlorophyll of Sajina leaves in monsoon and winter

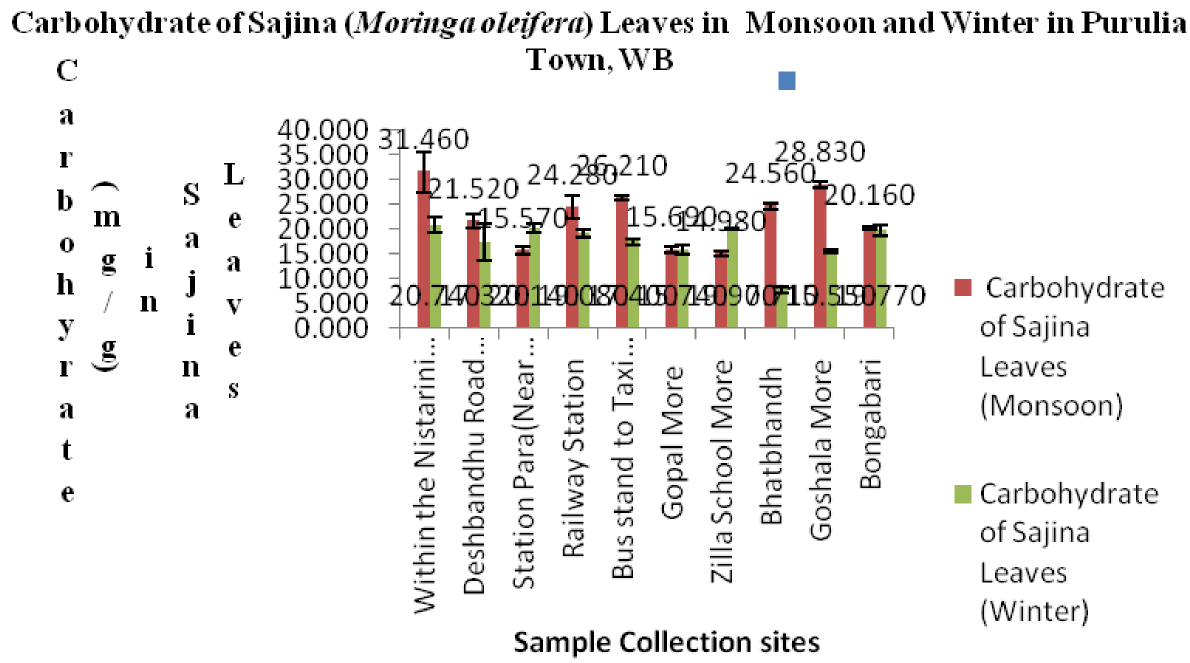

Fig. 9. Carbohydrate of Sajina leaves in monsoon and winter

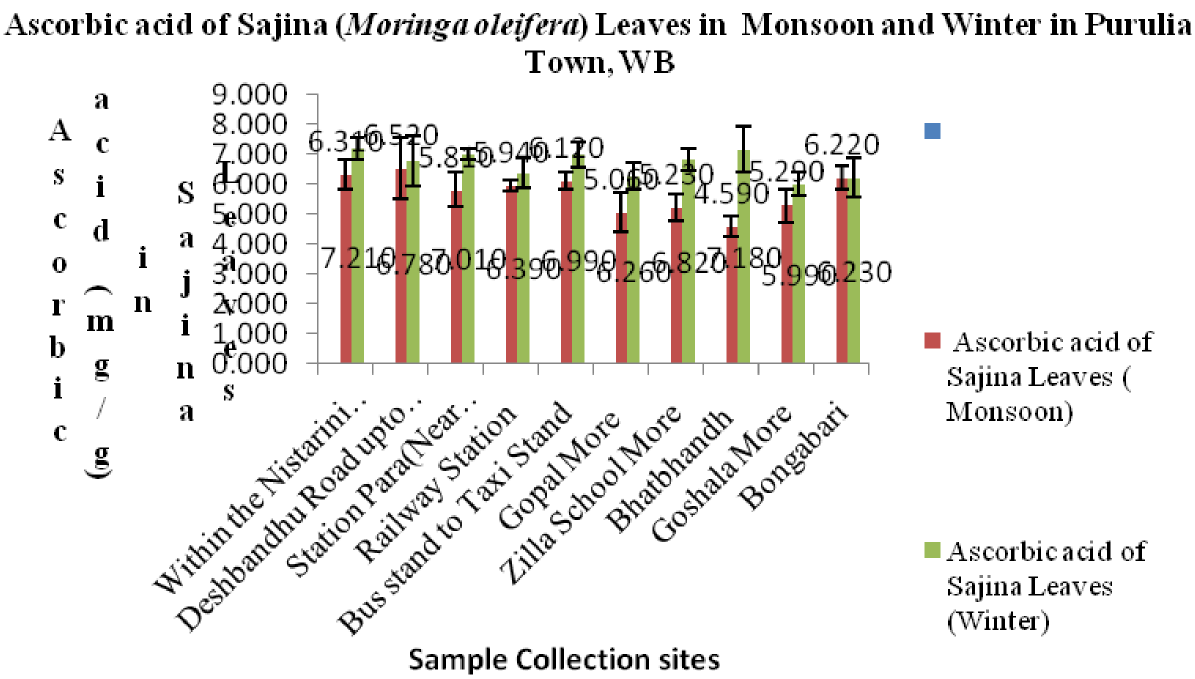

Fig. 10. Ascorbic acid of Sajina leaves in monsoon and winter

such as heavy metals deposited on the soil affect the performance of roots and hinder soil resource capture by the plant. This decline in resource capture will influence plant growth [17]. Plants when become incessantly exposed to pollutants, build up pollution incorporation capacity in to their own system and as a result of certain changes leaves turn out to be more sensitive towards pollution. During monsoon, accumulated dust particles are generally washed out from leaves while during winter and summer accumulation of dust is more. These dusts come into contact with cell sap and increase the pH level of plant leaves [18]. Chlorophyll is an index of productivity of plant which indicates its photosynthetic activity as well as the growth. Jyothi and Jaya (2010) had the view that high levels of automobile emission lessen chlorophyll content in roadside plants [19]. Ascorbic acid acts as a strong reductant and helps to build up defence mechanisms in plants. It's reducing activity become more at increased pH levels. The efficacy of conversion of hexose form of sugar to ascorbic acid and the ability to tolerate the pollution may increase at high pH [20]. RWC of leaves helps in retaining the physiological balance under stressed circumstances. RWC level is reduced in plant species due to the effect of pollutants on rate of transpiration in leaves [21]. Bhattacharya *et al.* (2013) noticed higher level of Relative Water Content during monsoon [22]. Das and Prasad (2010) also found high RWC value in rainy season, low in winter and least in summer [23]. Analysis of biochemical parameters of leaves assess this alteration and also facilitates to estimate the APTI values [24]. Manjunath and Reddy, (2019) observed from their survey work that APTI level of plants in polluted area was ranged from 9.42 to 25.87 while APTI of plants in non-polluted area was ranged from 8.77 to 19.21. Lowest APTI value was estimated from *O. sanctum* both from both polluted and non-polluted area at 9.42 and 8.77, respectively. This plant is sensitive to air pollution [25]. Agbaire and Esiefarienrhe, (2009) experienced that plants in comparatively polluted environment have higher APTI value than that of the less polluted environment [11]. Lohe *et al.*, (2015) also observed higher level of APTI of plants in polluted sites than that of non-polluted sites [26].

3.1 APTI of Neem *(Azadirachta indica)* in monsoon in sample collection sites (Fig. 11)

Goshala More > Zilla School More > Bhatbandh > Station para (near Maheswari lodge) > Bongabari > Nistarini College premises > Bus stand to Taxi stand > Deshbandhu Road near Raghabpur more > Railway station and surrounding areas > Gopal More.

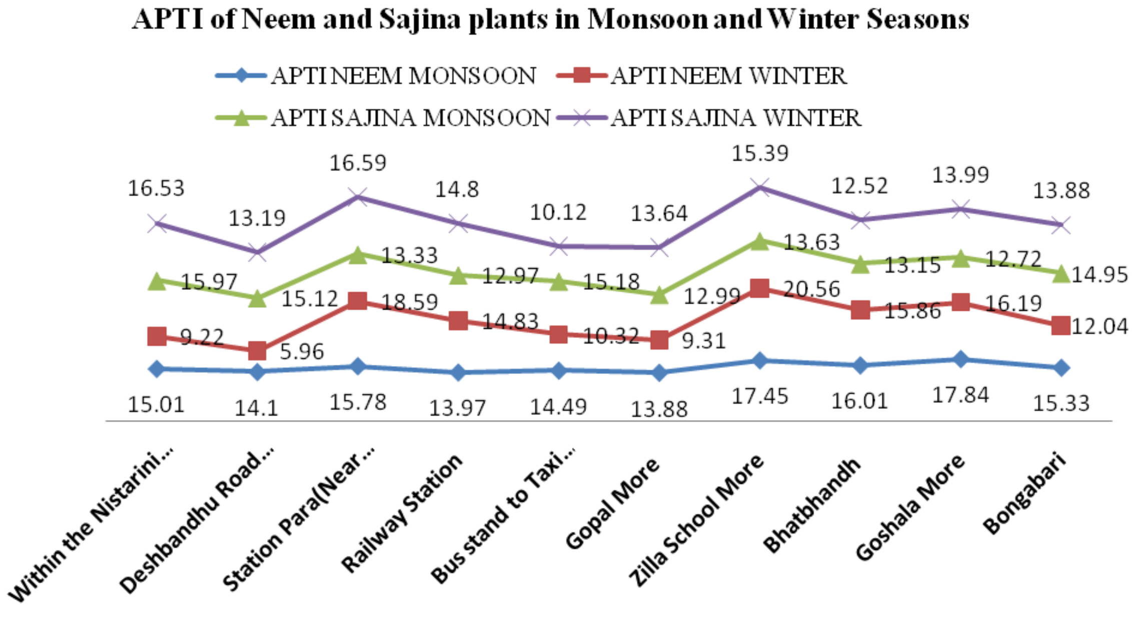

Fig. 11. APTI of Neem and Sajina plants in monsoon and winter

3.2 APTI of Neem *(Azadirachta indica)* in winter in sample collection sites (Fig. 11)

Zilla School More > Station para (near Maheswari lodge) > Goshala More > Bhatbandh > Railway station and surrounding areas > Bongabari > Bus stand to Taxi stand > Gopal More > Nistarini College premises > Deshbandhu Road near Raghabpur more.

3.3 APTI of Sajina *(Moringa oleifera)* in monsoon in sample collection sites (Fig. 11)

Nistarini College premises > Bus stand to Taxi stand > Deshbandhu Road near Raghabpur more > Bongabari > Zilla School More > Station para (near Maheswari lodge) > Bhatbandh Gopal More > Railway station and surrounding areas > Goshala More.

Table 1: $|t|$ test Result (biochemical parameters of *Azadirachta indica*) between Monsoon and Winter

Sample Collection Sites	pH	RWC	Chlorophyll	Carbohydrate	Ascorbic Acid
Within the Nistarini College Premises	4.24*	27.44**	7.74**	3.26*	2.50NSD
Deshbandhu Road upto Raghabpur More	6.36**	27.02**	6.84**	3.70*	2.73NSD
Station Para (Near Maheshwari Lodge)	11.31**	1.61NSD	9.94**	2.33NSD	0.95NSD
Railway Station	5.43**	2.69NSD	0.80NSD	3.43*	6.76**
Bus Stand to Taxi Stand	6.36**	10.52**	5.29**	5.15**	2.39NSD
Gopal More	6.26**	10.48**	5.27**	1.84NSD	4.27*
Zilla School More	0.27NSD	13.37**	5.12**	5.49**	3.11*
Bhatbhandh	3.50*	8.88**	0.56NSD	1.24NSD	2.85*
Goshala More	3.13*	6.51**	1.20NSD	7.53**	1.07NSD
Bongabari	2.45NSD	17.01**	9.20**	4.36*	6.23**

$|t|_{0.05,4} = 2.776^*$; $|t|_{0.01,4} = 4.604^{**}$; NSD-no significant difference

SD*-Significant Difference 95% level of confidence; SD**-Significant Difference 99% level of confidence

Table 2: $|t|$ test Result (biochemical parameters of *Moringa oleifera*) between Monsoon and Winter

Sample Collection Sites	pH	RWC	Chlorophyll	Carbohydrate	Ascorbic Acid
Within the Nistarini college premises	3.50*	1.39NSD	0.06NSD	4.19*	2.53NSD
Deshbandhu Road upto Raghabpur More	6.12**	10.51**	1.67NSD	1.88NSD	0.34NSD
Station Para (Near Maheshwari Lodge)	10.12**	0.51NSD	0.20NSD	6.22**	3.38*
Railway Station	38.18**	11.95**	2.23NSD	3.63*	1.48NSD
Bus stand to Taxi Stand	1.34NSD	63.46**	3.69*	23.25**	3.08*
Gopal More	49.50**	13.21**	3.64*	0.08NSD	2.58NSD
Zilla School More	8.05**	3.02*	0.25NSD	21.57**	4.88**
Bhatbhandh	7.07**	24.08**	8.78**	30.44**	5.51**
Goshala More	4.24*	2.86*	2.95*	30.87**	1.80NSD
Bongabari	4.24*	13.01**	6.42**	0.60NSD	0.02NSD

$|t|_{0.05,4} = 2.776^*$; $|t|_{0.01,4} = 4.604^{**}$; NSD-no significant difference

SD*-Significant Difference 95% level of confidence; SD**-Significant Difference 99% level of confidence

3.4 APTI of Sajina *(Moringa oleifera)* in winter in sample collection sites (Fig. 11)

Station para (near Maheswari lodge) > Nistarini College premises > Zilla School More > Railway station and surrounding areas > Goshala More > Bongabari > Gopal More > Deshbandhu Road near Raghabpur more > Bhatbandh > Bus stand to Taxi stand.

4. Conclusion

APTI estimation are of important use as with rapid increase of industries, factories, mining activities, construction activities, road extension, automobile emission, urban expansion and as a result of that deforestation enhance the danger of air pollution. With the help of APTI value, natural control method like green belt can be created especially in the threatened areas to reduce the ill effect of air pollution. The status of air quality of different sites of Purulia town was observed with the help of APTI level of Neem *(Azadirachta indica)* and Sajina *(Moringa oleifera)* plants and it was clearly established that Goshala More, Nistarini College premises were in comparatively stressed condition during monsoon while Zilla School More and Station para (near Maheswari lodge) were in worst air quality condition during winter.

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