International Journal of Natural and Social Sciences
Print: 2617-6637 < ISSN > Online: 2313-4461
IJNSS

Effects of herbicides on in-situ net mineralization of nitrogen in wheat field

Rakhi Rani Sarker[1, 2], M. Harun-or-Rashid[2] , M. Jahiruddin[1], M. Mofizur Rahman Jahangir[1]*

[1]Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202
[2]Soil Science Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2202

ARTICLE INFO

Article history

Received: 27 March
Accepted: 27 April

Keywords

Net nitrogen mineralization, wheat, floodplain soils, post emergence and pre emergence herbicides

Corresponding Author

M.M.R. Jahangir
mmrjahangir@bau.edu.bd

ABSTRACT

In conservation agricultural practices, adoption of herbicide has increased for crop protection but increased herbicide uses for soil health are being questioned. Two experiments were conducted to examine the effect of herbicide on net nitrogen mineralization rates in situ under field conditions. Both experiments were conducted at different treatments of post and pre emergence herbicides in the research farm of Bangladesh Agricultural University under Old Brahmaputra Floodplain (AEZ 9). Experiment-1 comprised of three post emergence herbicides and one control treatment [T_1-Control, T_2-2,4-D Amine, T_3-Carfentrazzone-ethyl+isoproturon (Affinity), T_4-Carfentrazzone-ethyl (Hammer)]. Composite soil sampling for post emergence herbicides was done at day 21 (days after planting, DAP) which was the day of herbicide and fertilizer application, day 22, 23, 24 and 25 (DAP) after herbicide application. Experiment-2 comprised of one most popular pre-emergence herbicides Pendimethalin (Panida) with manual weeded control treatment. Composite soil sampling for pre emergence herbicides was done at day 3 (DAP) which was the day of herbicide and fertilizer application; day 4, 5, 6 and 7 (DAP) after herbicide application. Both experimental designs were Randomized Complete Block Design (RCBD) with four replications. Herbicides were tested at their label rate compared with manual weeded control treatment. Tested post-emergence herbicides had no significant effect on N mineralization. The numerically higher concentration of NH_4^+-N and NO_3^--N was found in treatment T_4 (Carfentrazzone-ethyl). Tested pre- and post-emergence herbicides had no significant effect on soil NH_4^+ and NO_3^--N content. Similarly, pre-emergence herbicides Pendimethalin (Panida) had no significant effect on NO_3^--N production. The study revealed that commonly used herbicides have no short term inhibitory effect on nitrogen mineralization and nitrifying microorganism. The increase in nitrification process is an indication of increasing nitrifying microorganism and positive effect to the soil microbiota. Although tested herbicide did not differ significantly with respect to wheat grain, yet the higher grain yield was produced by Carfentrazzone-ethyl+isoproturon (Affinity).

INTRODUCTION

Management of weeds is the greater challenge in conservation agriculture (CA) system which requires huge labor cost. Using herbicides has increased for crop protection in the sustainable and progressing development of agriculture (Barchanska et al., 2013). Applying herbicide is a low-cost solution of crop protection from significant yield losses. Chemical methods of weed control in agricultural and non-agricultural lands are rapidly getting popular because of its time, labour and cost advantages. Though the efficiency of herbicides in controlling the weeds is important simultaneously its residual impact should also be considered for environmental safety. The fate of herbicides applied in agricultural ecosystems is governed by the transfer and degradation processes, and their interaction with soil microorganisms. Any change in their population and activity may affect nutrient cycling as well as availability of nutrients, which indirectly affect productivity and other soil functions (Baboo et al., 2013; Wang et al., 2008). The greater parts of chemical agents are not harmful to the soil ecosystems. They are degraded to safe products such as water and carbon dioxide which do not affect soil microorganisms (Milosevic et al., 2004). Some crop protection products may have toxic impacts on soil microbes

How to cite this article: Sarker RR, Rashid MH, Jahiruddin M and Jahangir MMR (2022). Effects of herbicides on in-situ net mineralization of nitrogen in wheat field. International Journal of Natural and Social Sciences, 9(4): 42-50. DOI: 10.5281/zenodo.8071620

and can also affect the soil nutrient mineralization (Pesakovic et al., 2011; Sebiomo et al., 2011; Kucharski et al., 2009). In crops where chemical protection products are not used correctly, pesticide residues are found in harvested plants (Lozwiecka and Kaczynski, 2011). However, being chemicals, herbicides can affect the community composition and functioning of soil microbial population which is largely unknown. Rose et al. (2016) revealed that the application of herbicides in soil is poisonous to the microbial population and resulted in reduced microbial biomass, soil heterotrophic respiration and activity of organic matter (OM) decomposing and nutrient-cycling microbes. Alterations of soil quality occurred due to the addition of herbicides in the soil (Saeki and Toyota, 2004). Soil microbes play an important role in the biogeochemical cycle, production of soil enzymes and the degradation of herbicides (Truu et al., 2008; Acosta-Martínez et al., 2007). Due to unavailability and high wage of labour, herbicides for weed control are getting popular rather than manual weeding. Infestation of broadleaf weed is very common in wheat which reduces both the yield and grain quality drastically (Zand et al., 2007). Limited pre and post-emergence herbicides are available in the market of Bangladesh to control broadleaf weeds. The pre emergence herbicide was sprayed directly on the soil surface before the emergence of crops hence affects soil chemical and microbial environment deeper than the post emergence ones. Assessing the effects of herbicides on the soil microbial environment is crucial for the judicious use of herbicides. We hypothesized that the impact of herbicides will influence on nitrogen mineralization and nitrifying microorganism. Therefore, investigation into the effects of herbicides on nitrogen mineralization and nitrifying microorganism can provide better understanding of the possible response of soil microorganisms to different herbicides. The objective of our research was to evaluate the effects of some commonly used herbicides on soil net nitrogen mineralization on winter wheat (*Triticum aestivum*) var. BARI Gom-29 in non-calcareous soils of Bangladesh. However, the effects of pre and post emergence herbicides on soil still need more researches.

MATERIALS AND METHODS

Experimental sites

Two different experiments were conducted on different treatment of post emergence and pre emergence herbicides at the research farm (Non-Calcareous Dark Grey Floodplain soils, hyperthermic Aeric Haplaquepts), Bangladesh Agricultural University under Old Brahmaputra Floodplain (AEZ 9). The experimental site located at 24.54°N latitude and 90.50°E longitude at a height of 18 m above the mean sea level. The climate is sub-tropical, which is characterized by high temperature, high humidity, and high rainfall in the summer monsoon season and low rainfall associated with moderately low temperature during the winter season. Soil contains 60, 30, and 10% sand, silt, and clay, respectively, with a sandy loam texture and a pH of 6.12 at 0-15 cm depth. Soil organic carbon (SOC) and total nitrogen (N) contents at 0-7.5 cm depth were 1.32% and 0.10%. Monthly average rainfall, temperature and relative humidity were collected from the nearest weather station at BAU campus, Mymensingh which was presented in Figure 1.

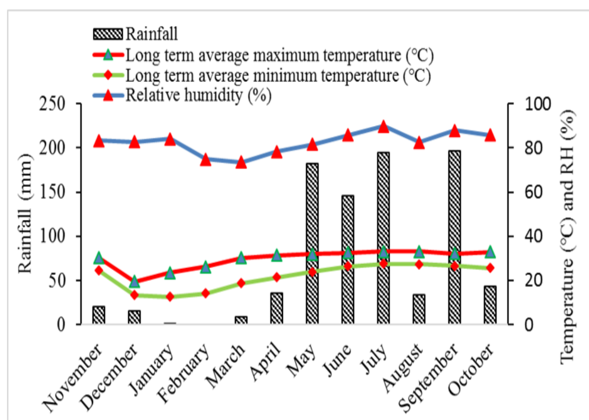

Figure 1: Weather data from November 2019 to October 2020 during wheat growing season at BAU, Mymensingh

Wheat as a winter crop was sown on 24 November 2019 and harvested on 8 March 2020. In the year of 2019 during the wheat growing period of November and December lower amount of (20 mm to 16 mm) rainfall received. In 2020, most of the rainfall received during the period of May, July and September (Figure 1). In the year of 2019 during the period of November and December a monthly maximum temperature was 30.2 ºC and 19.5 ºC whereas a minimum temperature was 24.5 ºC and 13.4 ºC, respectively (Figure 1). Similarly, in the year of 2019 during the period of November and December a monthly humidity was 83.4 and 82.7%, respectively (Figure 1).

Experimental design and cultural practices

Both experiments were conducted at Soil Science Field Laboratory, Bangladesh Agricultural University, Mymensingh during *rabi* season of 2019. Two different experiments were conducted to see the effects of post-emergence and pre-emergence herbicide on soil net nitrogen mineralization rates and bacterial population (indirectly count).

Experiments- 1

Four treatments were tested at their label rate in four replications. Experimental treatments were one control and three post emergence herbicides [T_1-Control (untreated with herbicide), T_2-2, 4-D Amine, T_3-Carfentrazzone-ethyl+isoproturon (Affinity), T_4- Carfentrazzone-ethyl (Hammer)]. Water was used as the herbicide carrier. The experimental design used was Randomized Complete Block Design (RCBD) with four replications. Location Soil Science Field Laboratory, Bangladesh Agricultural University. Tested crop was wheat (var. Bari gom-29). Plot size was 4m x 3m =12m^2.

Experiments- 2

The second experimental design was Randomized Complete Block Design (RCBD) with four replications. One pre-emergence herbicide Pendimethalin was tested against untreated control. Water was used as the herbicide carrier. The experimental design was Randomized Complete Block Design (RCBD) with four replications. The size of each plot was 4m x 3m =12m^2.

Cultural practices

The land was prepared with a power tiller. Weeds and stubbles of the previous crop were collected and removed from the field. After leveling the land by ladder, the experimental plots were laid out as per treatments and design. Wheat *(Triticum aestivum*) was sown on 24 November 2019 and harvested on 08 March 2020. BARI Gom-29 was used as a test variety for wheat. The seed rate of was 120 kg ha^{-1}. Seeds were sown in lines with 20 cm × 20 cm spacing. Standard cultural operations including weeding, gap filling, irrigation, and insecticides were performed as required. Supplemental sprinkler irrigation was used when needed for wheat. The wheat was irrigated three times during the crown root initiation (17 days after planting, DAP), jointing (54 DAP), and booting (65 DAP) stages. During final land preparation, the required amount of P, K, S, and Zn was applied in the form of triple superphosphate (TSP), muriate of potash (MoP), gypsum, and $ZnSO_4.7\ H_2O$, respectively. Urea was applied in three equal splits for wheat. Each crop was fertilized as per the recommendation of the Fertilizer Recommendation Guide, 2018 (FRG-2018).

Soil sampling, processing and analysis

Composite soils from both experimental plots were collected after harvesting of the wheat in 2020 using an auger at 0-15 cm soil depths from each replicated plot. A portion of the field-moist soils was 2-mm sieved, placed in sealable plastic bags, and temporarily stored in a refrigerator at 4°C prior to analysis of soil parameters. Another portion of the soils was air-dried and ground to pass through a 20-mesh sieve, and stored in sealable plastic bags for physical and chemical analysis. Soil particle size analysis was performed using the standard hydrometer method (Bouyoucos, 1927) and the textural class was determined following Marshall's triangular coordinate using the USDA system. Soil pH was measured with a glass electrode (HANNA, HI2211 pH meter) in the soil-water ratio being 1:2.5 as described by Jackson (1962). The SOC was determined by following the wet oxidation method (Walkley, 1947) and TN content was measured by the semi-micro Kjeldahl method (Fawcett, 1954).

Experiments-1

Soil sampling for biological properties was done at day 21 (days after planting, DAP) which is the day of herbicide and fertilizer application, day 22, 23, 24 and 25 (DAP) after post-emergence herbicide application. Herbicides were evaluated at their label rate. Total number of soil samples was 80 comprising (4 replications x 4 treatments x 5 sampling times).

Experiments-2

Soil sampling for biological properties was at day 3 (DAP) which is the day of herbicide and fertilizer application; day 4, 5, 6 and 7 (DAP) after pre-emergence herbicide application. Herbicides were evaluated at their label rate. Total number of soil samples was 40 (4 replications x 2 treatments x 5 sampling times).

Soil parameters studied

Experiments were conducted to see the effects of post-emergence and pre-emergence herbicide on soil net nitrogen mineralization (NH_4^+-N and NO_3^-- N) rates and bacterial population (indirectly count).

Determination of NH_4^+-N and NO_3^-- N by diffusion method

About 50 g of fresh soil samples were suspended in 150 ml of 2.0 *M* KCl solution and shaken for a period of 2 hr using an orbital shaker at 300 rpm. The suspensions were filtered through Whatman No. 1 filter paper. Aliquots of the filtrates were analyzed using distillation procedure with saturated boric acid solution by adding 0.7g MgO for NH_4^+-N and 0.3g MgO plus 0.4g Devarda's alloy for NO_3^-- N following Bremner & Keeney (1965) method. After distillation the distillate was titrate with 0.01 N H_2SO_4. The calculations of the concentrations were based on the oven dry basis.

Statistical analysis

A Randomized Complete Block Design (RCBD) two-way analysis of variance (ANOVA) was performed using herbicides treatment and net mineralization by Statistics-10®. Data were statistically analyzed to ascertain the significant differences for main effects and interactions among the treatments. If there was a statistically significant interaction, then the interaction was presented, but the main effects of the treatment factors that were involved in this interaction were not reported. Otherwise, only the main effects of treatments were presented. All the statistical analyses were considered significant at $p \leq 0.05$, unless otherwise mentioned.

RESULTS

Experiment 1: Effects of post-emergence herbicides on N mineralization

Tested post-emergence herbicides had no significant effect on N mineralization in terms of NH_4^+-N and NO_3^--N (Table 1). Apparently higher amount of NH_4^+-N mineralization was recorded in treatment T_4 (Carfentrazzone-ethyl) showing the mean value 36.3 ppm and in T_3 (Carfentrazzone-ethyl+isoproturon) showing 36.2 ppm NH_4^+-N. The lowest amount of NH_4^+-N (33.8 ppm) and NO_3^--N (11.3 ppm) was observed in control (T_1) treatment. Amount of NO_3^--N was statistically similar among the applied herbicides. In a value higher amount of NO_3^--N was recorded in treatment T_4 (13.1 ppm).

Table 1: Average NH_4^+-N and NO_3^--N concentration for various post-emergence herbicides

Treatment	NH_4^+-N (ppm)	NO_3^-- N (ppm)
T_1 (Control)	33.8	11.3
T_2 (2, 4-D Amine)	35.8	11.5
T_3 (Carfentrazzone-ethyl+isoproturon)	36.2	12.0
T_4 (Carfentrazzone-ethyl)	36.3	13.1
SE (±)	1.52	0.72
CV (%)	8.6	11.9
Level of significance	ns	ns

Means separated by same letter were non-significant and different letter were significant at 5% level; ns, not-significant; *-significant at 5% level, SE=Standard Error

Effects on NH_4^+-N content release with time

The mean concentrations of NH_4^+-N of the soils treated with the various herbicides are presented in Table 2 showing time series results. Day 21 (DAP) was the day of herbicide and fertilizer applications. Gradually the day 22, 23, 24 and 25

(DAP) was the days of soil sampling after post-emergence herbicide application. Four treatments were applied including T_1-Control, T_2-2, 4-D Amine, T_3-Carfentrazzone-ethyl+isoproturon and T_4- Carfentrazzone-ethyl.

From Table 2, it was observed that there was no statistically significant effect among the different sampling days after herbicide application. In a value higher concentrations of NH_4^+- N were found in the soil at day 22 (DAP), which was the day after applications in the treatment T_3 (41.0 ppm) than the subsequent sampling days. Similarly, higher concentrations of NH_4^+- N (39.8 ppm) of T_4 was found in the soil at day 22 (DAP). In case of treatment T_2, higher amount of NH_4^+-N (36.5 ppm) was found at day 23 (DAP). From the average NH_4^+ -N content released with time, it was observed that NH_4^+ -N concentration trended to increase just after the application of urea and post emergence herbicide, but the treatment was not significant. After attaining a temporary peak, the NH_4^+ -N concentration fell down gradually to become stable near to control treatment (Table 2). From the NH_4^+-N data after urea and herbicide application it can be concluded that the applied herbicide had no significant inhibitory effect on N mineralization.

Table 2: Average NH_4^+ -N content (ppm) release with time

In-situ time in the field (days)	Treatments			
	T_1	T_2	T_3	T_4
d21	34.1	35.5	35.3	36.0
d22	33.4	35.6	41.0	39.8
d23	29.4	36.5	36.0	36.0
d24	35.9	34.9	31.8	34.1
d25	35.9	36.5	37.0	35.5
SE (±)	2.07	2.34	2.57	2.21
LSD at 0.05	6.37	7.22	7.91	6.81
CV (%)	12.26	13.11	14.19	12.19
Level of significance	ns	ns	ns	ns

Means separated by same letter were non-significant and different letter were significant at 5% level, *-significant at 5% level, SE=Standard Error

Effects on NO_3^-- N content release with time

The mean concentrations of NO_3^-- N of the soil that released with time (days) are presented in Table 3. It was observed that the NO_3^-- N concentration of treatments T_1, T_2 and T_4 did not vary significantly with the days after herbicide applications from 21 to 25 (DAP) except T_3 treatment. In T_3 [Carfentrazzone-ethyl+isoproturon (Affinity)] treatment NO_3^-- N concentration suddenly significantly decreased just after the day of fertilizer and herbicide application (22 DAP). Concentrations of NO_3^-- N again linearly increased with time and from day 23 to 25 days mean concentration of NO_3^-- N (ppm) was numerically similar. The NO_3^-- N concentration ultimately reached stable condition near control treatment (Table 3).

Table 3: Average NO_3^-- N content (ppm) release with time

In-situ time in field (days)	Treatments			
	T_1	T_2	T_3	T_4
d21	12.75	15.65	13.75a	13.15
d22	9.81	10.91	7.11b	12.80
d23	9.96	10.91	12.33a	14.57
d24	11.97	9.48	14.22a	14.22
d25	12.25	12.80	12.80a	10.91
SE (±)	1.38	1.79	1.59	1.42
LSD at 0.05	4.28	5.53	4.89	4.39
CV (%)	24.5	31.2	26.4	21.8
Level of significance	ns	ns	*	ns

Means separated by same letter were non-significant and different letter were significant at 5% level; ns, not-significant. *- significant at 5% level, SE=Standard Error

Experiment 2: Effects of pre-emergence herbicides on N mineralization

Due to lower number of treatment, T-test was performed in this experiment to evaluate the effect, of pre-emergence herbicide (Pendimethalin) on nitrogen mineralization. Treatment T_2 contributed significantly to NH_4^+-N production than T_1 treatment (Table 4). Non-significant but numerically higher amount of NO_3^-- N was recorded in treatment T_2 than in T_1.

Table 4: Average NH_4^+-N and NO_3^-- N concentration after treatment of pre-emergence herbicide (Pendimethalin)

Treatment	NH_4^+-N (ppm)	NO_3^-- (ppm)
T_1 (Control)	30.3b	7.83
T_2 (Pendimethalin)	34.0a	7.96
SE (±)	0.63	0.33
Level of significance	*	ns

Means separated by same letter were non-significant and different letter were significant at 5% level, ns, not-significant. *- significant at 5% level, SE=Standard Error

Effects on NH_4^+-N released with time

The mean concentrations of soil NH_4^+-N released with time was non-significant in control treatment (T_1) and significant in T_2. Higher concentration of NH_4^+-N was found in the soil at day 4 (DAP), which is the day after applications in both treatments. After the day 4 (DAP), the NH_4^+-N content gradually decreased with time and one time it become stable (Figure 2).

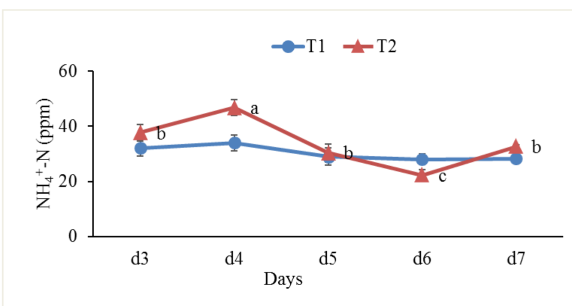

Figure 2: Effects of pre-emergence herbicide on NH_4^+-N release with time

Effects on NO_3^--N release with time

The daily mineralization (NO_3^-- N) rate for treatment T_1 and T_2 varied non-significantly with days of sampling. Higher concentrations of NO_3^--N in the soil were observed at day 3 and 4 (DAP). Then mineralization rate decreased at day 5 (DAP). After that at day 6 and 7 (DAP) it again increased for both treatments T_1 and T_2 (Figure 3).

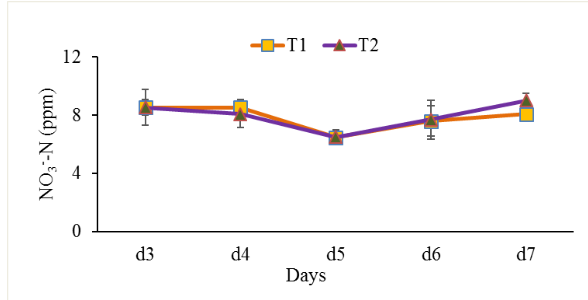

Figure 3: Effects of pre-emergence herbicide on NO_3^--N content release with time

Effects of herbicides on wheat yield

Herbicide treatments had no significant effect on the yield of wheat (Table 5). Although tested herbicide did not differ significantly with respect of wheat grain and straw, yet the higher number of grains (4.12 t/ha) and straw (4.96 t/ha) yield were obtained from T_3 treatment (carfentrazone-ethyl plus isoproturon). Similar yield results were found with treatment T4 (Carfentrazzone-ethyl). The lower grain (3.95 t/ha) and straw (4.23 t/ha) yields were recorded from T_1 (control) treatment.

Table 5: Effects of post-emergence herbicides on wheat yield

Treatments	Grain (t/ha)	Straw (t/ha)
T_1 (Control)	3.95	4.23
T_2	4.04	4.97
T_3	4.12	4.96
T_4	4.10	4.82
SE (±)	0.27	0.46
CV (%)	13.2	19.6
Level of significance	ns	ns

Means separated by same letter were non-significant and different letter were significant at 5% level; ns, not-significant., SE=Standard Error

Pre-emergence herbicide had non-significant effect on both grain and straw yields of wheat. Higher grain yield (4.13 t/ha) and straw yield (4.96 t/ha) were recorded in treatment T_2 (Pendimethalin) compared to control (no herbicide application) (Table 6).

Table 6: Effects of pre-emergence herbicide on wheat yield

Treatment	Grain (t/ha)	Straw (t/ha)
T_1 (Control)	4.06	4.85
T_2 (Pendimethalin)	4.13	4.96
SE (±)	0.22	0.48
CV (%)	10.72	19.81
Level of significance	ns	ns

Means separated by same letter were non-significant and different letter were significant at 5% level; ns, not-significant; SE=Standard Error

DISCUSSIONS

Effects of herbicides on N mineralization and soil microbes

There was no short term inhibitory effect of any tested herbicides on both NH_4^+-N and NO_3^-- N mineralization and nitrifying microorganism. Negligible impacts of herbicides was found on soil microbial communities and beneficial soil functions when applied at recommended field-application rates (Rose et al., 2016). Similar report also reviewed by Bunemann et al. (2006) who revealed that the herbicides generally had no major effects on soil organisms. Rose et al. (2016) observed that application of glyphosate at recommended rate did not significantly affect the respiration. It was noticed that the microbial populations and enzyme activities are recovered after initial transient inhibition perhaps the microbe gets adapted to these herbicides or due to their degradation. Simultaneously, where the plants die following herbicide application, the plant debris provides an increased supply of nutrients resource to support microbial growth and activity (Sondhia et al. 2013; Maheswari and Ramesh 2019).

Nguyen et al. (2016) found that field application rates of glyphosate herbicide had no significant effect on soil microbial respiration and soil microbial biomass. Similarly, Newman et al. (2016), and Kepler, et al. (2020) found no overall effect of glyphosate on bacterial community diversity. Imfeld and Vuilleumier (2012) suggested that pesticides on soil micro-organisms have minor effects when they are applied at the recommended doses. Kocak et al. (2021) concluded that, the recommended field dose of Indaziflam had no negative effect on microorganisms that play an active role in soil carbon and nitrogen mineralization. They found that the recommended field dose of herbicide containing indaziflam had generally no negative effect on soil carbon and nitrogen mineralizations.

We observed that both NH_4^+-N and NO_3^-- N production increases during nitrogen mineralization process. This study observed that nitrifying microorganism also increases after the application of tested herbicide on wheat as nitrification process is an indicaton of positive effect to the microbiota. Tomkiel et al. (2015) found that the optimal dose of Carfentrazzone-ethyl (CE) increased the counts of spore-forming oligotrophic bacteria, organotrophic bacteria and bacteria of the genus Azotobacter in soil. They established that CE act as a source of nutrients and energy that’s why the most intensive growth of organotrophic bacteria, Actinomycetes and fungi was reported in the first four days of the experiment. Tyagi et al. (2018) concluded that the effect of herbicides on soil microbes is only temporary. The adverse effects of herbicides were gradually reduced with passage of time and practically, there was no adverse effect of acetochlor, 2, 4-Diethyl ester and atrazine herbicides on soil microbial activities in terms of fungi, bacteria and actinomycetes population after harvest of maize.

Adomako and Akyeampong, (2016) indicated that the presence of Atrazine, 2, 4-D amine, Glyphosate and Paraquat in the soil exert considerable change in the growth and development of soil microorganism. The toxic effect of some of the herbicide was felt shortly after its application whilst herbicide treatment like Paraquat had lasting effect on most microorganisms. For instance, the population of bacteria sharply increased to about 87.2% but steeply declined to 6.4% from the 10 DAT to 15 DAT. In this experiment the % organic matter seems not to be influenced by the herbicide exposure. Similarly, Xu et al. (2017) reported that sterane first decreased soil bacterial diversity and abundance in maize field at 10 days but increased them at 60 days after application

Tested herbicide Carfentrazzone-ethyl+ isoproturon (Affinity) non-significantly produced higher grain yield than control treatment. According to Afrifa et al. (2010) three possible sources are responsible to contribute to the NH_4^+-N concentration in bin soil. These are due to decomposition of plant litter, degradation of the pesticides and lastly from the soil nitrogen source. Herbicides can increase vegetable residue decomposition rates due to a greater detachment of leaves and roots caused by senescence. Thus, they may have a beneficial physical effect on stubble mineralization (Snapp & Borner, 2005). Pendimethalin steadily increased the total population of bacteria, fungi and actinomycetes in soil under cotton after a short lag phase during the crop growth period (Balasubramanian and Sankaran 2001).

CONCLUSIONS

We observed that both NH_4^+-N and NO_3^-- N production increases during nitrogen mineralization process so from this study we can conclude that nitrifying microorganism also increases after the application of tested herbicide on wheat. The numerically higher concentration of NH_4^+-N and NO_3^--N was found from application of Carfentrazzone-ethyl (Hammer). The increase in nitrification process is an indication of positive effect to the microbiota. There is a strong connection between the herbicide, nitrogen mineralization and the nitrifying microorganisms. This study suggested that application of tested pre and post emergence herbicides at the label rate on wheat have no short term inhibitory effect on nitrogen mineralization and nitrifying microorganism. Moreover, numerically higher grain and straw yields were recorded from label rate application of carfentrazone-ethyl plus isoproturon (Affinity). Therefore, we can conclude that application carfentrazone-ethyl (Hammer) or carfentrazone-ethyl plus isoproturon (Affinity) at the label rate on wheat as a profitable weed control practice.

Acknowledgements

The authors acknowledge World Bank for funding this research under the National Agricultural Technology Program-Phase II Project (NATP-2).

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

Adomako MO and Akyeampong S (2016). Effect of some commonly used herbicides on soil microbial population. Journal of Environment and Earth Science, 6(1).

Acosta-Martinez V, Cruz L, Sotomayor-Ramirez D and Perez-Alegria L (2007). Enzyme activities as affected by soil properties and land use in a tropical watershed. Applied Soil Ecology, 35(35): 45.

Afrifa AA, Wood M and Ofori-Frimpong K (2010). The Effects of Benomyl and Glyphosate Treated Plant Litter on Nitrogen Mineralization in Mollisols. West African Journal of Applied Ecology, vol. 17.

Balasubramanian K and Sankaran S (2001). Effect of pendimethalin on soil microorganisms. India. Agricultre, 45: 93-98.

Bremner JM and Keeney DR (1965). Inorganic forms of nitrogen. In Methods of Soil Analysis. (D. A. Black, ed.). American Society of Agronomy.

Baboo M, Pasayat M, Samal A, Kujur M, Maharana JK and Patel AK (2013). Effect of four herbicides on soil organic carbon, microbial biomass-C, enzyme activity and microbial populations in agricultural soil. International Journal of Environmental Science and Technology,. 3(4): 100-112.

Barchańska H, Czaplicka M and Giemza A (2013). Simultaneous determination of selected insecticides and atrazine in soil by MAE–GC–ECD. Archives of Environmental Protection, 39(1): 27–40.

Bunemann EK, Schwenke GD and Zwieten VL (2006). Impact of agricultural inputs on soil organisms—a review. Soil Research, 44(4): 379–406.

Fawcett JK (1954). The semi-micro Kjeldahl method for the determination of nitrogen. Journal of Medical Laboratory Science & Technology, 12: 1-22.

FRG (2018). Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council, BARC. Farmgate, Dhaka: Soils pub., Bangladesh Agricultural. Research Council.

Imfeld G and Vuilleumier S (2012). Measuring the effects of pesticides on bacterial communities in soil: A critical review. European Journal of Soil Biology, 49: 22–30.

Jackson ML (1962). Soil Chemical Analysis. Prentice hall Inc., Engle Wood Cliffs, N J USA.

Kocak B, Cenkseven S, Kızıldağ N, Sağlıker HA, and Darıcı C (2021). How did the Addition of Indaziflam effect on Carbon and Nitrogen Mineralizations in a Vineyard Soil? International Journal of Life Science and Biotechnlgy. DOI: 10.38001/ijlsb.751731

Kucharski J, Bacmaga M and Wyszkowska J (2009). Effect of herbicides on the course of ammonifi cation in soil. Journal of Elementology, 14(3): 477–487.

Lozowicka B and Kaczynski P (2011). Pesticide residues in apples (2005–2010), Archives of Environmental Protection, 37(3): 43–54.

Maheswari ST, Ramesh A (2019). Fate and persistence of herbicide residues in India. In: Sondhia S, Choudhury PP, Sharma AR (eds) Herbicide residue research in India. Springer. Singapore. pp 1–28.

Milošević NA, Govedarica MM and Cvijanović G (2004). Microorganisms as indicators of herbicide effect on biological activity of soil. Acta Herbologica, 13(1): 243–250.

Nguyen DB, Rose MT, Rose TJ, Morris SG and van Zwieten L (2016). Impact of glyphosate on soil microbial biomass and respiration: A meta-analysis. Soil Biology and Biochemistry, 92: 50–57.

Newman MM, Hoilett N, Lorenz N, Dick RP, Liles MR, Ramsier C and Kloepper JW (2016). Glyphosate effects on soil rhizosphere-associated bacterial communities. Science of The Total Environment, 543: 155–160.

Pešaković M, Milenković S, Dukić D, Mandić L, Glišić I and Luković J (2011). Soil microbial activity as infl uenced by integrated and conventional production systems, Archives of Environmental Protection, 37(3): 79–85.

Rose MT, Cavagnaro TR, Scanlan CA, Rose TJ, Vancov T and Kimber S (2016). Impact of Herbicides on Soil Biology and Function. In D. L. Sparks (Ed.), Advanced Agronomy, 136: 133–220. Academic Press.

Saeki M and Toyota K (2004). Effect of bensulfuron-methyl (a sulfonyurea herbicide) on the soil bacterial community of a paddy soil microcosm. Biology and Fertility of Soils, 40: 110-118.

Sebiomo A, Ogundero WV, Bankloe SA (2011). Effect of four herbicides on microbial population, soil organic matter and dehydrogenase activity, African Journal of Biotechnology, 10(5): 770–778.

Snapp SS and Borden H (2005). Enhanced nitrogen mineralization in mowed or glyphosate treated cover crops compared to direct incorporation Plant and Soil, Dordrecht. 270(1/2): 101-112.

Sondhia S, Waseem U, Varma RK (2013). Fungal degradation of an acetolactate synthase (ALS) azosulfuron ethyl in soil. Chemosphere, 93: 2140–2147.

Tomkiel M, Baćmaga M, Wyszkowska J, Kucharski J and Borowik A (2015). The effect of carfentrazone-ethyl on soil microorganisms and soil enzymes activity. Archives of Environmetal Protection, 41: 3–10.

Truu M, Truu J and Ivask M (2008). Soil microbiological and biochemical properties for assessing the effect of agricultural management practices in Estonian cultivated soils, European Journal of Soil Biology, 44: 231–237.

Tyagi S, Mandal SK, Kumar R and Kumar S (2018). Effect of different herbicides on soil microbial population dynamics in Rabi maize (Zea mays L.) Int. International Journal of Current Microbiology and Applied Sciences, Special Issue-7: 3751-3758.

Wang QK, Wang SL and Liu YX (2008). Responses to N and P fertilization in a young Eucalyptus dunnii plantation; microbial properties, enzyme activities, and dissolved organic carbon, Applied Soil Ecology, 40: 484-490.

Walkley A (1947). A critical examination of a rapid method for determining organic carbon in soils effect of variations in digestion conditions and of inorganic soil constituents. Soil Science, 63: 251-264.

Xu YR, Fang ZJ, Lu XP and Hao LJ (2017). Effects of starane on maize soil bacterial diversity analyzed by high-throughput sequencing technology. Acta Microbiologica Sinica,, 57(7): 985–993.

Zand E, Baghestani MA, Soufizadeh S, PourAzar R and Veysi M, et al. (2007). Broadleaved weed control in winter wheat (Triticum aestivum L.) with post-emergence herbicides in Iran. Crop Protection, 26: 746-752.