SOIL MICROBIAL BIOMASS NITROGEN AND SOIL PROPERTIES RESPONSE BY DIFFERENT GLUCOSE-C ADDITIONS IN BLACK SOIL OF CHINA

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Abstract: *A pot study in incubators comprised on 106-days weres conducted with black soil contained 29.3% clay used under long term experiment in Jilin province of China to determine the effects of glucose addition patterns (single and repeated additions) on soil microbial biomass Nitrogen and soil properties. 40 g air dried was filled into 250 ml Schott bottle. All the Schott bottles contained soils were arranged in CRD-factorial design with 4 repeats. Factor (A), included glucose addition patterns such as single addition (received all amount of glucose-C at the start of the experiment), repeated addition (received the same amount of glucose in five splits) while control received water only. Factor (B), consisted on different soil fertility levels: soil I M_0N, soil II, M_0NP, soil III M_2CK, soil IV M_4CK and soil V M_4NPK. After that glucose-C (2%) solution was added drop wise to soil by using pipette for uniform distribution. The additions pattern showed variable impact on Soil Microbial biomass Nitrogen and Soil properties. Single and repeated additions increased 21.6% and 13.4% more Soil Microbial biomass Nitrogen over to control. Overall average basis soil-M_4CK soil produced (70%) more SMBN as compared to soil-M_0N, followed by soil-M_4NPK (63%). It can be concluded that single addition showed higher Soil Microbial biomass Nitrogen and soil properties response in initial incubation period (2^{nd} week), later on upto 14^{th} week repeated additions showed higher Soil microbial biomass Nitrogen and N mineralization as compared to single addition.*

Keywords: Soil Microbial biomass Nitrogen, Soil Properties, Glucose, Addition patterns.

INTRODUCTION

Soil organic matter (SOM) is the main component of carbon and nutrient cycling, it is a major nutrient source of plant growth (after microbial decomposition), it is also major carbon reservoir of the biosphere atmosphere system [1]. Soil carbon and nitrogen are driving factors of most microbial processes, particularly soil respiration and mineralization. The quality of the carbon is particularly important because it constrains the supply of energy for the production of enzymes and growth. Factors that are responsible for processes such as soil organic matter, addition pattern of SOM, application method, soil types and different soil fertility, etc, beside these factors many biotic factors directly affect on carbon mineralization in soil. The changes are due to microbial activity as a response to changed amounts and availability of carbon and nitrogen. Single addition is the application of glucose or fresh organic material (maize straw), farmyard manure at initial time or at the beginning of the experiment. Repeated addition is the application of Organic substrates per week, fortnightly, monthly throughout the experimental duration, the same amount of substrate is applied to each treatment over the study period. Some materials contain less readily available energy than glucose and fructose because of their polymerized structure, the rate of SOM mineralization does not seem to be influenced by individual response to change in the amount of available energy. This states that the priming effect depends mostly on the dynamics of SOM degrading populations. Any increase in these populations due to a greater availability of energy originating from input of fresh organic matter to soil, should accelerate SOM mineralization. However the supply of easily assessable compounds to soils, such as glucose, fructose and mineral nutrients induces little effect on SOM mineralization, compared to effect of cellulose or wheat straw [2]; [3]. Keeping in view the above facts a study with black soil was proposed to determine the effects of glucose addition patterns (single and repeated additions) on soil microbial biomass Nitrogen and soil properties.

MATERIALS AND METHODS

Soils

The topsoil (0–20 cm) had a SOC of 16.1 g kg^{-1}, total N 1.9 g kg^{-1}, total P 1.39 g kg^{-1}, and total K 22.1g kg^{-1}, respectively. Available N (alkali-hydrolizable), P (Olsen-P), and K (1 mol L^{-1} NH_4OAc) were 114, 27, and 190 mg kg^{-1}, respectively. Soil pH (1:2.5 w/v, distilled water) was 7.6 and soil clay content (<2 μm) was 29.3%. The soil used in this incubation study was collected from top 20 cm of soil which has been involved with mono-cropping of maize, and now it's under long term experiment in Jilin province of China. Before use the soil samples were air dried, homogenized and sieved in 2mm sieve. The stones, plant roots and other material were carefully removed. The soil is considered as a middle layer black soil with clay content (<2 μm) 29.3%, pH ranged of 6.8 to 7.2 (0.01 M $CaCl_2$ 1:4), water holding capacity (WHC) 58.5 to 61.8% (w/w) and it was maintained at 60% throughout the experiment. Soil organic carbon (SOC) varied from 15.86 to 31.46 g/kg.

Table 01. Chemical properties of different fertility levels of black soil used in study.

Means ± SE, n = 3

No.	Soil	WHC (%)	pH	SOC (g kg^{-1})
1	M_0N	59.2 ± 0.029	7.19 ± 0.012	16 ± 0.018
2	M_0NP	58.5 ± 0.053	7.59 ± 0.018	15.9 ± 0.021
3	M_2CK	61.8 ± 0.042	7.25 ± 0.015	26.3 ± 0.007
4	M_4NCK	59.5 ± 0.059	6.85 ± 0.018	30.2 ± 0.094
5	M_4NPK	58.5 ± 0.018	6.81 ± 0.38	31.5 ± 0.017

Experimental design

40 g air dried, 2 mm sieved, homogenized and mixed well soil, after addition of aforesaid glucose additions filled into 250 ml Schott bottle. The soil moisture content was adjusted with distilled water to 60% water holding capacity. All the Schott bottles contained soil were pre-incubated in dark chamber at 20 ^{0}C and relative humidity of 62% and left open during incubation (for 7 days). Thereafter water or glucose-C (2%) solution was added drop wise to soil by using the pipette to obtain uniform distribution. Five milliliters of 1M NaOH were placed in small bottles in each incubation Schott bottle to trap CO_2 and replaced at every week. Carbon dioxide samples were trapped from incubation bottle and analyzed for CO_2 efflux in every week. One gram of $CaCl_2$ added to small bottle and placed in the incubation bottle to absorb water vapor and prevent soil moisture from subsequent water additions. After 210 h, the decomposition rates strongly slowed down and to minimize possible C-discrimination [4], [5;6].

Analysis of Soil Microbial biomass Nitrogen

After the incubation, soil microbial biomass Nitrogen (SMBN) was quantified by chloroform fumigation/extraction method. About 12.5 g of fresh soil was fumigated with ethanol chloroform for 24 hours, additional 12.5 g soil was not fumigated with ethanol free chloroform for 24 hours and then extracted with 50 ml of 0.5 mol/L K_2SO_4 in same manner, the total concentration in K_2SO_4 extracted in fumigated – non fumigated soils. Soil microbial biomass Nitrogen SMBN were analyzed five times throughout the experiment, at week 3, 6, 9, 12 and 15, respectively. Microbial biomass nitrogen (mg/g) was analyzed by Analytic jena Multi N/C 3100 (TOC/TN) while change its mode on NPOC.

Statistical analysis

Each treatment contained four replicates. The data of SMBN at the end of the experiment was analyzed by three-way ANOVA (analysis of variance) with C glucose addition pattern (control, single and repeated additions), nutrient/fertility levels (M_0N, M_0NP, M_2CK, M_4CK & M_4NPK) and time (weeks) as (glucose additions × nutrient/fertility levels × weeks). Tukey HSD test was employed to assess significant differences by using software Statistix® Version 8.1. The data were plotted using non metric multi-dimensional scaling (MDS) plot. Significant differences in SMBN among the treatments were determined at probability HSD(≤ 0.05).

RESULTS

Change in soil microbial biomass nitrogen (SMBN) by glucose addition patterns

Soil microbial biomass nitrogen also depicted significant F values (p = 0.00) from the ANOVA (analysis of variance) for the amended soils, glucose-C additions and time in weeks. The interaction between soils × addition patterns, addition pattern × time and soils × addition pattern × time, were also varied with highly significant F-values (p = 0.000).

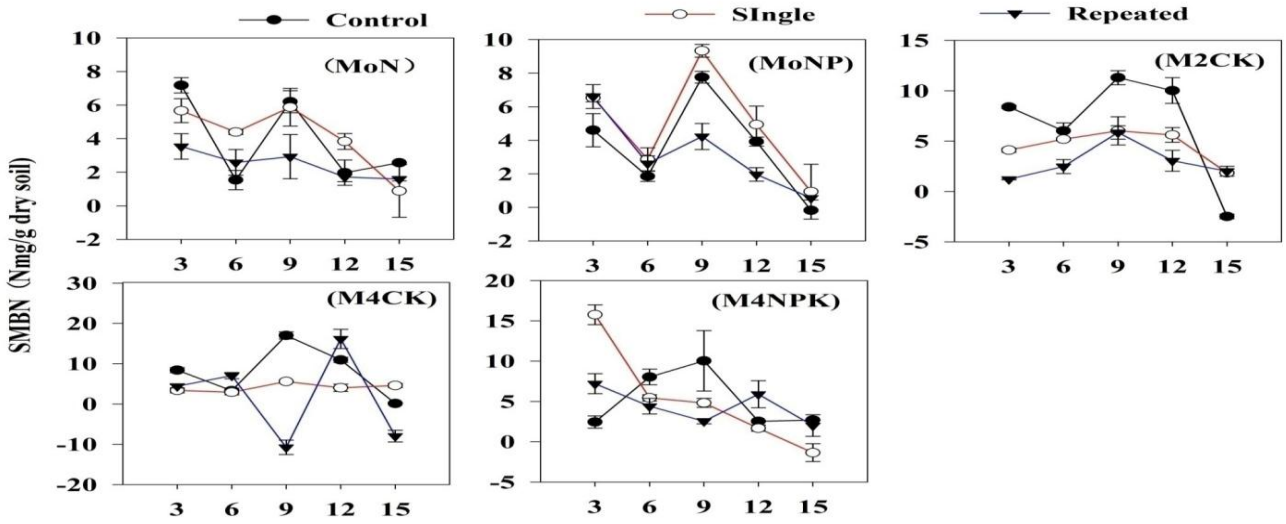

Fig 01: Soil microbial biomass nitrogen response with different glucose-C additions in black soils.

The glucose-C additions depicted variable effects on SMBN of various amended soils used in study. Repeated addition illustrated greater SMBN by control (18 mg g^{-1}dry soil) in M_4CK followed by single addition (15.5 mg g^{-1} dry soil) in M_4NPK amended soil during 9th week of incubation period. The maximum SMBN on average basis (4.95 mg g^{-1} dry soil) produced by repeated addition which was 19.2% and 18.1% higher than control (4.15 mg g^{-1} dry soil) and single addition (4.19 mg g^{-1} dry soil). The M_4NPK amended soils used in study showed highest mean SMBN (5.93 mg g^{-1}) which 11%, 21%, 71% and 133% over to M_4CK (4.32 mg g^{-1}), M_2CK (4.9 mg g^{-1}), M_0NP (3.46 mg g^{-1}) and M_0N (2.54 mg g^{-1}), respectively.

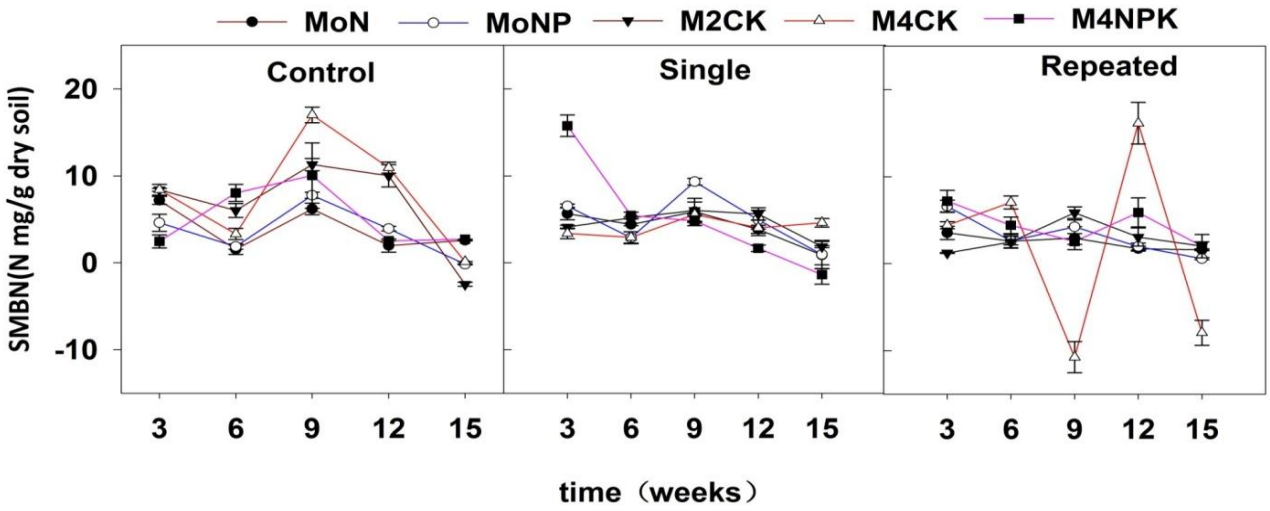

Fig02: Soil Microbial biomass Nitrogen in different soil fertility of Black Soils.

The highest average SMBN observed in 9th week of study period, which was 1%, 13%, 45% and 911% over to mean SMBN of 3rd, 12th, 6th and 15th week of study period. The positive interaction was observed amended soils and glucose-C additions. The repeated addition × M_4NPK amended soil showed 22 times more SMBN than M0NP ×single addition, glucose addition ×time (mean wise) showed 20 times more by repeated addition × 3rd week than control × 15th week of study. The interaction of amended soil × glucose addition × time illustrated that M_4CK×single addition × 9th week produced 84.5% more SMBN than M_0NP × single addition ×9th week of study period.

DISCUSSION

The amount of N mineralization varied depending on the amount of glucose addition alone or with mineral fertilizers. Organic amendments can stimulate microbial growth and nutrient uptake as well as plant growth and nutrient uptake. Microbes can increase plant nutrient availability by nutrient mobilization but also because nutrients taken up by the microbial biomass initially could become available to plants when the microbial biomass turns over as the easily available C is depleted [7]. Glucose addition had a significant influence on the respiration of soil microbes, with manure application stimulating microbial activity [8] due to the increased annual additions of C inputs. The glucose-C additions depicted variable effects on SMBN of various amended soils used in study. Repeated addition illustrated greater SMBN by control in M_4CK followed by single addition in M_4NPK amended soil during 9th week of incubation period. The maximum SMBN on average basis produced by repeated addition which was 19.2% and 18.1% higher than and single addition. The M_4NPK amended soils used in study showed highest mean SMBN which 11%, 21%, 71% and 133% over to M_4CK, M_2CK, M_0NP and M_0N, respectively. The strong increase of the available N concentration from day 0 to day 10 indicates that N supply from residues exceeded microbial demand. The high concentration of water-extractable organic C in the low C/N residue may also have contributed to its high decomposability [9] and [10].

CONCLUSION

The findings of our study reveal the scope of glucose additions. Single glucose-C addition augmented Microbial biomass Nitrogen for shorter period, while the repeated addition of glucose enhanced Soil microbial biomass Nitrogen for longer incubation period. So, it can be suggested that repeated addition of glucose may be studied for longer incubation period and in more sub-splits for prominent response of microorganisms Nitrogen mineralization.

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