

GROWTH PARAMETERS AND SOIL FERTILITY STATUS AS INFLUENCED BY NITROGEN SOURCE IN WHEAT

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Abstract: In order to study morphological response of wheat to different nitrogen sources a field experiment was conducted during the *rabi* season of 2017-2018 at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar. The soil of the experimental field is slightly alkaline in reaction, sandy loam in texture, low in organic carbon and nitrogen, medium in available phosphorus and potassium. The experiment was laid out in Randomized Block Design replicated thrice with ten treatments viz. T₁ (Control), T₂ (Vermicompost @ 6 t ha⁻¹), T₃ (*Azotobacter* + Vermicompost @ 6 t ha⁻¹), T₄ (30 kg N ha⁻¹ + Vermicompost @ 3 t ha⁻¹), T₅ (40 kg N ha⁻¹ + Vermicompost @ 2 t ha⁻¹), T₆ (50 kg N ha⁻¹ + Vermicompost @ 1 t ha⁻¹), T₇ (30 kg N ha⁻¹ + *Azotobacter* + Vermicompost @ 3 t ha⁻¹), T₈ (40 kg N ha⁻¹ + *Azotobacter* + Vermicompost @ 2 t ha⁻¹), T₉ (50 kg N ha⁻¹ + *Azotobacter* + Vermicompost @ 1 t ha⁻¹) and T₁₀ (60 kg N ha⁻¹). The results of the experiment indicated that no variations in plant population at 15 DAS and N, P and K status of soil after harvesting of wheat crop was observed due to application of various combinations of nitrogen fertilizer, vermicompost and *Azotobacter*. Among various treatments of nitrogen fertilizer, vermicompost and *Azotobacter* T₁₀ was at par with T₈ and T₉ for plant height at all the stages of crop growth. Treatment T₁₀ at all the stages of crop growth resulted in highest dry matter accumulation. Treatment T₁₀ (100 % RDN) being at par with treatment T₉ and T₈ required significantly higher number of days to attain physiological maturity than all other treatments. Treatment T₁₀ resulted in highest grain yield which was at par with treatments T₈ and T₉ and significantly higher than all other treatments. Straw yield obtained with treatment T₁₀, was significantly higher than all other treatments except T₉. Highest biological yield was recorded with treatment T₁₀ which was at par with treatments T₈ and T₉.

Keywords: Growth parameters, Nitrogen, Soil, Wheat

INTRODUCTION

Wheat popularly known as “Staff of life or king of cereals” has been described as a strategic cereal crop for the majority of the world’s population which is rich in carbohydrates and protein so it has its own outstanding importance as a human food. Wheat is cultivated in at least 43 countries of the world. The leading countries in wheat cultivation are China, India, Thailand, Indonesia and U.S.A. and total production of wheat was 647 million tonnes under area of 218million hectares with a productivity of 2960 kg/ha (FAO, 2012).The continuous use of chemical fertilizers in indiscriminate manner has developed many problems like decline of soil organic matter, increase in salinity and sodicity, deterioration in the quality of crop produce, increase in hazardous pests and diseases and increase in soil pollutants (Chakarborti and Singh, 2004). On account of continuing energy crisis in the world and spiraling price of fertilizer, the use of organic manure as a renewable source of plant nutrients is gaining importance. In this endeavor proper combination of inorganic and organic fertilizer is important not only for increasing crop yield but also for sustaining soil health (Weber et al., 2007 and Pullicino et al., 2009). The vermicomposting is bio-oxidation and stabilization of organic material involving the joint action of earthworm and microorganisms. Although, microbes are responsible for the biological degradation of the organic matter, earthworms are

the important drivers of the process, conditioning the substrate and altering biological activity (Aira et al., 2002).The use of organics largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives, enriches the soil, encourages bio-diversity, reduce the toxic bodies, improves water quality, creates a safe environment for people and wild life, produces nutritious food of high quality, supply micronutrients in soil and maintains soil fertility and crop productivity (Sawrup, 2010). Wheat requires a good supply of nutrients especially nitrogen for its growth (Mandal et al., 1992). Keeping the above aspects in view, the present investigation “Morphological response of wheat to different nitrogen sources in semi arid climate of Haryana” has been planned with the objective to study the effect of vermicompost and *Azotobacter* on growth characters of *desi* wheat.

MATERIALS AND METHODS

Field experiment was conducted during *rabi* 2017-2018 at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar which is situated at latitude of 29°10’ North, longitude of 75°46’ East and elevation of 215.2 m above mean sea level in the semi-arid, subtropical climate zone of India. The experiment was laid out in Randomized Block on sandy loam (63.5% sand, 17.3% silt and 19.2% clay) soil which is slightly alkaline in reaction, low in organic carbon and

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nitrogen, medium in available phosphorus and potassium. The treatments were comprised of ten treatments viz. T₁ (Control), T₂ (Vermicompost @ 6 t ha⁻¹), T₃ (*Azotobacter* + Vermicompost @ 6 t ha⁻¹), T₄ (30 kg N ha⁻¹ + Vermicompost @ 3 t ha⁻¹), T₅ (40 kg N ha⁻¹ + Vermicompost @ 2 t ha⁻¹), T₆ (50 kg N ha⁻¹ + Vermicompost @ 1 t ha⁻¹), T₇ (30 kg N ha⁻¹ + *Azotobacter* + Vermicompost @ 3 t ha⁻¹), T₈ (40 kg N ha⁻¹ + *Azotobacter* + Vermicompost @ 2 t ha⁻¹), T₉ (50 kg N ha⁻¹ + *Azotobacter* + Vermicompost @ 1 t ha⁻¹) and T₁₀ (60 kg N ha⁻¹). *Azotobacter* was. Prior to sowing, the seed pertaining to inoculated plots was treated with *Azotobacter* culture obtained from Department of Microbiology, CCS Haryana Agricultural University, Hisar, as per treatment. The seed was wetted with sugar solution and 50 ml of bio inoculants was used as per the recommendation. The treated seed was kept in shade for the completion of inoculation. Both treated and untreated seeds were sown as per the treatments. Sowing of *Desi* wheat C 306 was done on 10th November 2017 at about 5.0 cm depth by drilling in rows using 120 kg seed ha⁻¹ and spacing of 20 cm between rows. Pre-sown irrigation of 5 cm depth was applied on 3th November 2017. Three post sown irrigations were applied on 04.12.2017, 27.02.2018 and 13.03.2018. Harvesting was done with the help of sickles manually by cutting the plants from the net area of each plot separately on 11th April 2018. Full dose of phosphorus (62.5 kg P₂O₅ ha⁻¹) and half nitrogen as per treatments were applied at the time of sowing and remaining half of the nitrogen was top dressed at 23 DAS.

Full dose of P and half dose of N as per treatments were applied to the field before sowing and rest of N was top dressed after first irrigation. Urea (46%), Diammonium phosphate (18% N, 46% P₂O₅), and *Azotobacter* were used as source of N and P. Physiological maturity was determined by pressing the grain between thumb and index finger. At this stage, the material inside the grain is solid and hard and does not yield to mild pressure. Five representative plants from each plot were selected randomly and tagged for recording the effect of different treatments on yield attributes. Plant height of five randomly tagged plants was recorded at 30, 60, 90 DAS and at maturity. The height of each plant was measured with the help of wooden scale from the soil surface to fully opened top leaf of the plant before ear emergence and up to the ear head after heading stage. Plants were harvested from 50 cm row length from two places in the second row on either side in each plot at 30, 60, 90 DAS and at harvest. These harvested plants (above ground parts) were sun dried first and then oven dried at 60°C till a constant weight was obtained at each stage and weighed. All yield attributing characters were recorded periodically on these randomly selected and tagged plants.

RESULTS AND DISCUSSION

Data related to plant population at 15 DAS of *desi* wheat are presented in Table 3 indicated that various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* did not affect the plant population at 15 DAS of *desi* wheat. The plant population of *desi* wheat varied from 37.9 to 39.4. Treatment T₁₀ (100 % RDN) being at par with treatment T₉ for physiological maturity required significantly higher number days to attain physiological maturity as compared to other treatments. Days taken to physiological maturity were reduced by nine days under treatment T₁ (Control) as compared to T₁₀ (100 % RDN). Data presented in Table 1 indicated that among various combinations of nitrogen fertilizer, *Azotobacter* and vermicompost treatment T₁₀ (100 % RDN) was at par with treatment T₈ and T₉ at all the stages of crop growth and resulted in significantly taller plants than other treatments. However, plant height at maturity in treatment T₈ and T₉ were recorded at par with each other. The plant height at maturity was 36 cm, 32 cm and 27 cm more in treatment T₁₀, T₉ and T₆ treatments compared to the control (110 cm), respectively. The magnitude of plant height recorded under various treatments varied from 110 cm under control (T₁) to 146 cm under treatment T₁₀ at harvest. Lowest plant height was recorded in treatment T₁ at all the stages of crop growth. This might be due to nitrogen concentration in plant resulting in higher photosynthetic activity and thereby rapid cell division and cell elongation and consequently taller plant. Improved growth and yield attributes increased with increased dose of N, may be due to fact that N being an important constituent of nucleotides, proteins, chlorophyll and enzymes involves in various metabolic process which has a direct impact on vegetative and reproductive phase of plants. Results reported by Rathore *et al.* (2003), and Shirinzadeh *et al.* (2013) reported similar results. Taller plants in treatment containing vermicompost may be owing to increased supply of multi-nutrients, plant growth regulators and beneficial microflora released from vermicompost in addition to the most favourable conditions with respect to physico-chemical and biological properties of the soil. At higher level of nitrogen, crop absorbed sufficient amount of N, resulting in better growth parameters such as plant height, dry matter accumulation, number of tillers. Nitrogen application increased plant height (Moreno *et al.*, 2003; Meena *et al.*, 2012) and tillering (Birch and Long, 1990), which ultimately led to higher dry matter production. Irrespective of the treatments, dry matter accumulation at various growth stages of *desi* wheat increased progressively from vegetative to maturity stage (Table 2). The rate of dry matter accumulation per mrl was slow up to initial 30 days and highest between 60 to 90 DAS and thereafter the increase was at a decreasing rate up to maturity. Among

various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* treatment, application of 100% RDN at all the stages of crop growth resulted in significantly higher dry matter accumulation. This might be due to combined effect of nitrogen fertilizer, vermicompost and *Azotobacter* in balanced proportion played a very crucial role in decomposition and easy release of different nutrients and their uptake by wheat crop which led to higher dry matter production and its translocation in different plant parts of growth and yield parameters, which in turn resulted into higher yield. These results are in complete agreement with those of Ram and Mir (2006) and Kakraliya (2017).

A thorough look on data indicated that grain yield of *desi* wheat was significantly higher in treatment T₁₀ (100% RDN). But, the differences in grain yield in treatments T₁₀ (28.2 q ha⁻¹), T₉ (27.8 q ha⁻¹) and T₈ (26.3 q ha⁻¹) were not significant. This might be due to combined effect of fertilizer and *vermicompost* might have resulted in easy release of different nutrients and their uptake by wheat crop which led to higher better growth and higher yield parameters, which in turn resulted into higher grain yield. These results are in complete agreement with those of Ram and Mir (2006) and Kakraliya *et al.*, (2017). Straw yield was highest in treatment T₁₀ (76.4 q ha⁻¹), being significantly higher than other treatments but statically at par with treatment T₉ (74.6 q ha⁻¹). The straw yield in treatment T₅ (68.3 q ha⁻¹) and T₆ (70.6 q ha⁻¹), T₇ (68.7 q ha⁻¹) and T₈ (71.2 q ha⁻¹) were also

at par with each other. Biological yield was recorded highest with treatment T₁₀ with biological yield of 104.60 q ha⁻¹. But, the difference in biological yield in treatment T₈, T₉ and T₁₀ were not significant. Significantly lower value for biological yield was recorded in treatment T₁ (53.60 q ha⁻¹) which was statistically lower than rest of the treatments. The biological yield in treatment T₄ (84.90 q ha⁻¹) and T₅ (92.73 q ha⁻¹) was statistically at par with each other. Similarly, the difference in biological yield in treatment T₅ (92.73 q ha⁻¹), T₆ (96.10 q ha⁻¹), T₇ (93.30 q ha⁻¹) and T₈ (97.50 q ha⁻¹) were also not significant. Improvement in yield of wheat might have resulted from favourable influence of fertilizers, *Azotobacter* and vermicompost on the growth attributes and efficient and greater partitioning of metabolites and adequate translocation of photosynthates and nutrients to developing reproductive structures. These results confirm the findings of Singh and Kumar (2010).

The influence of various treatments on available N, P and K content in soil was recorded after harvest of wheat crop. Data for same have been given in Table 4. A close perusal of the data on nutrient status of soil revealed that there was no significant difference resulted due to application of various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* on N, P and K status of soil after harvesting of wheat. The range of soil N status varies from 140.8 (T₁) to 165.4 (T₃).

Table 1. Plant height (cm) of *desi* wheat as influenced by various combinations of nitrogen fertilizer, vermicompost and *Azotobacter*

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At Maturity
T ₁ : Control	19	46	81	110
T ₂ : Vermicompost @ 6 t/ha	22	49	96	117
T ₃ : <i>Azotobacter</i> + Vermicompost @ 6 t/ha	23	50	104	125
T ₄ : 30 kg N /ha + Vermicompost @ 3 t/ha	22	49	106	131
T ₅ : 40 kg N /ha + Vermicompost @ 2 t/ha	23	51	107	134
T ₆ : 50 kg N /ha + Vermicompost @ 1 t/ha	23	52	109	137
T ₇ : 30 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 3 t/ha	26	51	111	136
T ₈ : 40 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 2 t/ha	25	52	113	139
T ₉ : 50 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 1 t/ha	26	54	115	142
T ₁₀ : RDN (60 kg N ha ⁻¹)	27	57	120	146
SEm ±	0.4	0.5	0.5	1.6
CD at 5 %	1.3	1.6	1.5	4.6

Table 2. Dry matter accumulation (g/ml) of *desi* wheat as influenced by various combinations of nitrogen fertilizer, vermicompost and *Azotobacter*

Treatments	Dry matter accumulation (g/ml)			
	30 DAS	60 DAS	90 DAS	At Maturity
T ₁ : Control	16	34	94.5	140.8
T ₂ : Vermicompost @ 6 t/ha	18	39	106.2	157.2
T ₃ : <i>Azotobacter</i> + Vermicompost @ 6 t/ha	19	41	109.5	162.0
T ₄ : 30 kg N /ha + Vermicompost @ 3 t/ha	18	40	106.8	158.4
T ₅ : 40 kg N /ha + Vermicompost @ 2 t/ha	19	41	111.9	165.6
T ₆ : 50 kg N /ha + Vermicompost @ 1 t/ha	19	42	114.9	169.2
T ₇ : 30 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 3 t/ha	22	42	112.8	167.2
T ₈ : 40 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 2 t/ha	21	43	114.3	169.2
T ₉ : 50 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 1 t/ha	22	45	119.1	176.4
T ₁₀ : RDN (60 kg N ha ⁻¹)	23	47	127.8	188.4
SEm ±	0.6	1.1	2.7	6.9
CD at 5 %	1.9	3.5	8.2	20.7

Table 3. Grain yield, straw yield, biological yield and harvest index of *desi* wheat as influenced by various combinations of nitrogen fertilizer, vermicompost and *Azotobacter*

Treatments	Plant population at 15 DAS	Days to physiological maturity	Grain yield (q/ha)	Straw yield (q/ha)
T ₁ : Control	38.3	131	15.1	38.5
T ₂ : Vermicompost @ 6 t/ha	39.0	133	20.8	50.3
T ₃ : <i>Azotobacter</i> + Vermicompost @ 6 t/ha	39.4	134	21.3	52.5
T ₄ : 30 kg N /ha + Vermicompost @ 3 t/ha	37.9	135	22.7	62.2
T ₅ : 40 kg N /ha + Vermicompost @ 2 t/ha	38.3	136	24.4	68.3
T ₆ : 50 kg N /ha + Vermicompost @ 1 t/ha	39.0	137	25.5	70.6
T ₇ : 30 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 3 t/ha	39.4	137	24.6	68.7
T ₈ : 40 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 2 t/ha	38.3	137	26.3	71.2
T ₉ : 50 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 1 t/ha	39.0	138	27.8	74.6
T ₁₀ : RDN (60 kg N ha ⁻¹)	39.4	140	28.2	76.4

SEm ±	1.02	0.9	0.74	1.31
CD at 5 %	N.S.	2.7	2.23	4.01

Table 4. Effect of various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* on NPK status of soil

Treatments	N (kg ha ⁻¹)	P ₂ O ₅ (kg ha ⁻¹)	K ₂ O (kg ha ⁻¹)
T ₁ : Control	140.80	15.80	110.02
T ₂ : Vermicompost @ 6 t/ha	163.60	18.30	119.07
T ₃ : <i>Azotobacter</i> + Vermicompost @ 6 t/ha	165.40	18.00	120.69
T ₄ : 30 kg N /ha + Vermicompost @ 3 t/ha	158.30	18.40	124.20
T ₅ : 40 kg N /ha + Vermicompost @ 2 t/ha	153.60	18.80	121.05
T ₆ : 50 kg N /ha + Vermicompost @ 1 t/ha	148.40	19.10	121.14
T ₇ : 30 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 3 t/ha	164.30	19.80	127.99
T ₈ : 40 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 2 t/ha	160.70	19.50	129.16
T ₉ : 50 kg N /ha + <i>Azotobacter</i> + Vermicompost @ 1 t/ha	157.40	19.70	130.71
T ₁₀ : RDN (60 kg N /ha)	151.20	16.30	121.16

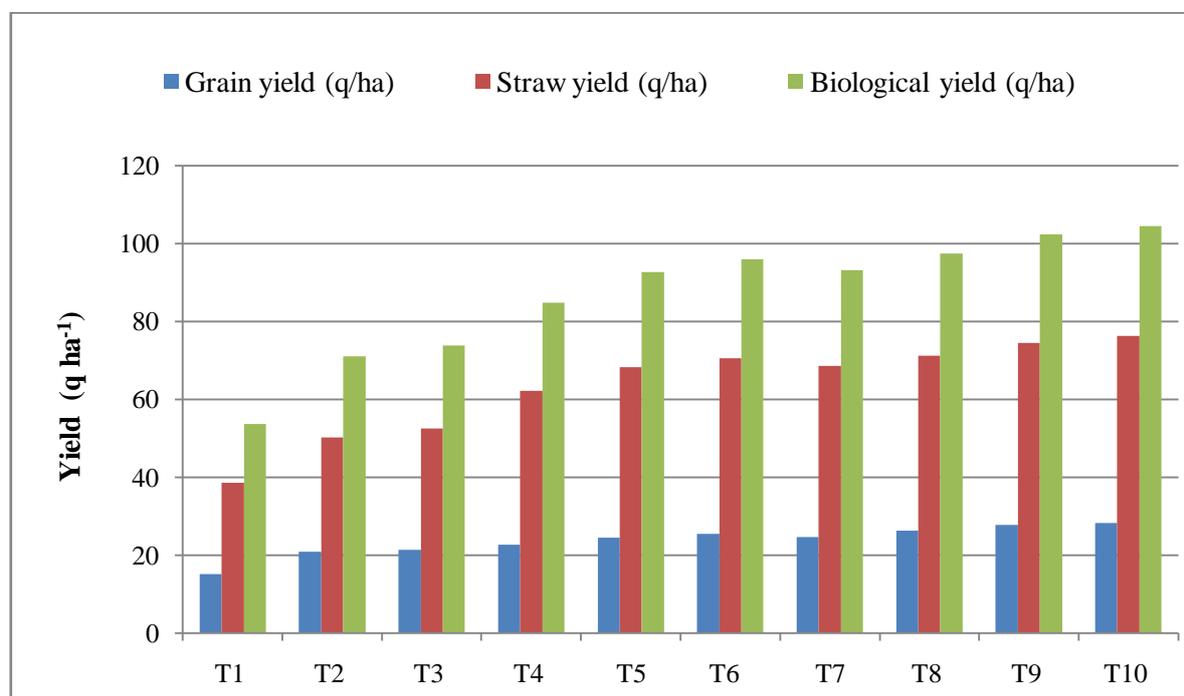


Figure 1: Grain, straw and biological yield (kg ha⁻¹) of *desi* wheat as influenced by various treatments

CONCLUSION

Among various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* T₁₀ recorded significantly higher growth parameters viz. [plant

height (cm) and dry matter accumulation/plant], grain straw and biological yield of *desi* wheat. But various treatments failed to produce any significant variation in plant population and soil nutrient status.

REFERENCES

- Aira, M., Monroy, F., Dominguez, J. and Mato, S.** (2000). How earthworm density affects microbial biomass and activity in pig manure. *European Journal Soil Biology*, **38**, 7-10.
- Birch, C. J. and Long, K. E.** (1990). Effect of nitrogen on the growth, yield and grain protein content of barley (*Hordeum vulgare*). *Australian Journal of Experimental Agriculture*, **30**(2), 237-242.
- Chakarborty, M. and Singh, N. P.** (2004). Bio-compost: a novel input to the organic farming. *Agrobios Newsletter*, **2** (8), 14-15.
- FAO** (2012). The state of the world's land and water resources for food and agriculture. FAO/AGL Publication, FAO, Rome
- Kakraliya, S. K.** (2017). Participatory assessment of portfolios of climate smart agricultural practices for adapting rice-wheat cropping system to climate variability in climate smart villages of Haryana. Ph.D. thesis submitted to CCSHAU, Hisar
- Meena, L. R., Mann, J. S. and Meena, S. L.** (2012). Effect of levels and mode of nitrogen application on dual purpose barley (*Hordeum vulgare* L.) under semi-arid condition. *Indian Journal of Agronomy*, **57** (2), 168-170.
- Moreno, A., Moreno, M.M., Ribas, F. and Cabello, M.J.** (2003). Influence of nitrogen fertilizer on grain yield of barley (*Hordeum vulgare* L.) under irrigated conditions. *Spanish Journal of Agricultural Research*, **1**(1), 91-100.
- Pullicino, D. S., Massacesia, L., Dixon, L., Bolb, R. and Gigliottia, G.** (2009). Organic matter dynamics in a compost-amended anthropogenic landfill capping-soil. *European J. Soil Sci.*, **61**: 35-47.
- Ram, T. and Mir, M.S.** (2006). Effect of integrated nutrient management on yield and attributing characters of wheat (*Triticum aestivum* L.). *Indian Journal of Agronomy*, **51** (3), 189-192.
- Rathore, V.S., Singh, P. and Gautam, R.C.** (2003). Influence of planting patterns and integrated nutrient management on yield, nutrient uptake and quality of rainfed pearl millet. *Annals of Agriculture Research*, **25** (3), 373-376.
- Shirinzadeh, A., Soleimanzadeh, H. and Shirinzadeh, Z.** (2013). Effect of seed priming with plant growth promoting rhizobacteria (PGPR) on agronomic traits and yield of barley cultivars. *World Applied Sciences Journal*, **21** (5), 727-731.
- Singh, R.V. and Kumar, Rajeev** (2010). Effect of organic and inorganic fertilizers on growth, yield and quality and nutrients uptake of wheat under late sown condition. *Progressive Agriculture*, **10** (2), 341-344.
- Swarup, A.** (2010). Integrated plant nutrient supply and management strategies for enhancing soil quality, input use efficiency and crop productivity. *Journal of the Indian Society of Soil Science*, **58** (1), 25-31.
- Weber, J., Karczewska, A., Drozd, J., Licmar, M., Licznar, S. and Jarnroz, E.** (2007). Agricultural and ecological aspects of a sandy soil as affected by the application of municipal solid waste composts. *Soil Biol. Biochem.*, **39**: 1294- 02.