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Effect of vermicompost and microbial inoculants on soil health , growth and yield of HD 2687 wheat (*Triticum aestivum*)

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ABSTRACT

The effect of vermicompost and microbial inoculants on soil health and wheat (*Triticum aestivum* L. emend Fiori & Paol.) (cv HD 2687) yield were studied for three field trials during 2006–08. The microbial inoculants used were *Azospirillum*, *Azotobacter*, PSB and AM fungi. Treatments included vermicompost (Vc) @ 6 tonnes/ha; Vc + *Azotobacter* + *Azospirillum*; Vc + PSB + AM fungi ; Vc + *Azotobacter* + PSB + AM and Vc +*Azospirillum*+PSB+AM fungi. The soil organic carbon content improved from 0.25% to 0.68% in three years in treatment amended with vermicompost alone. Inoculation of biofertilisers further improved the organic carbon content during the period of three years. Maximum carbon content was recorded in treatment inoculated with *Azotobacter*+PSB+AM fungi along with vermicompost. The N% also increased in the soil due to inoculation of *Azotobacter* and *Azospirillum*. Maximum grain yield of 3.11 q/ha was obtained in plots amended with vermicompost and co-inoculated with *Azospirillum* and *Azotobacter*.

Key words: *Azotobacter*, *Azospirillum*, Dehydrogenase activity, Phosphate solubilising bacteria, Soil organic carbon, Vermicompost

Crop productivity in organic farming is achieved by a combination of management strategies, among which the development of an efficient and effective nutrient cycle plays an important role. This is due to the large scale export of nutrients through produce and stubble, which in conventional systems is replaced by chemical fertilizers, whereas animal manure, cover crops or vermicompost, *ex situ* or *in situ* green manures are used individually or in combination to replenish exported nutrients in organic systems. In agricultural systems where organic matter is used, not only the replenishment of nutrients but also soil physical, chemical and biological properties are benefited. Soil is considered a storehouse of microbial activity, though the space occupied by living microorganisms is estimated to be less than 5% of the total space. Therefore, major microbial activity is confined to the 'hot-spot', i e aggregates with accumulated organic matter; rhizosphere (RS).Soil microorganisms play an important role in soil processes that determine plant productivity. For successful functioning of introduced microbial bioinoculants and their influence on soil health, exhaustive efforts have been made to explore soil microbial diversity of indigenous community, their distribution and behaviour in soil habitats. Vermicomposting is an effective means of composting the decomposable organic wastes using earthworms and its nutrient level 1-1.5%N, 0.6-0.8%P and 1.2-1.5% K respectively.

Rice and wheat, the two most staple food crops of India, are cultivated as wheat–rice cropping sequence worldwide by farmers. However, intensive use of chemical fertilizer has resulted in increased soil salinity leading to deterioration of soil health. Moreover, the cultivation practices of two food-grains are completely different; as rice requires waterlogging, which creates microaerophilic to anaerobic environment, which may change the rhizosphere microbial community. When wheat is sown in the same field, the microbial community structure has to change to aerobic resulting in alteration in soil biological equilibrium. Wheat–rice ecosystem is therefore of central interest to explore for sustainable agriculture. SOM and soil productivity are closely linked and organic amendments play an important role in the improvement of soil structure and soil organic matter (SOM) content. The use and management of crop residues, farm yard manure and green manuring are increasingly important aspect of environmentally sound sustainable agriculture. The future sustainability will depend on biofertilizers, enriched compost, vermicompost and organic amendments. Rice–wheat production system generates 10 – 14 Mg/ha of crop residues annually. The purpose of present studies was to study the effects and benefits of vermicompost and microbial inoculants on crop yield and soil properties.

MATERIAL AND METHODS

An experiment was conducted continuously for three years on the same field at IARI, New Delhi from 2006–08. There were total five treatments applied to wheat cv HD 2687. Vermicompost was broadcasted @ 6 tonnes/ha and seeds were treated with various microbial inoculants.

The following treatments were applied: T_1, Vermicompost (Vc); T_2, vermicompost + *Azotobacter* + *Azospirillum* (Vc + Azt + Azs); T_3, vermicompost +phosphate solubilising bacteria+ arbuscular mycorrhizae (Vc+ PSB+ AM); T_4, vermicompost + *Azotobacter* + phosphate solubilising bacteria +arbuscular mycorrhizae (Vc + Azt + PSB + AM); T_5, vermicompost+ phosphate solubilising bacteria +arbuscular mycorrhizae (Vc +Azs+PSB+AM)

All the treatment combinations were arranged in randomized block design with three replications. Plots were 6.6 m long and 5 m wide. After rice harvest, wheat was sown in the last week of November each year 2006, 2007 and 2008. Before sowing, the land was tilled three to four times with a disc and harrow followed by planking. Wheat variety HD 2687 during 2006–08 was sown (100 kg seed/ha) in rows 20 cm apart to a depth of about 5 to 6 cm using a hand-drawn plough. The seeds were coated with microbial inoculants before sowing (The sugar solution was prepared and culture packet was completely mixed in it and then the seeds were added, mixed nicely and dried under shadow before sowing). Among all bacteria, *Azotobacter* and *Azospirillum* were used for N fertilizer while PSB as phosphate solubilizer and AM with multiple roles mobilization, solubilization etc.

Depending on the seasonal rainfall, 2 or 3 more flood irrigations of about 7.5 cm were applied at maximum tillering and flowering and also at the milking stage.Soil samples were collected at mid and before harvest and each soil sample was a composite from five locations within a plot. The soil samples were mixed thoroughly, air dried, passed through a 2 mm sieve, and stored in plastic bags for analysis. Soil organic C (SOC) was determined by Walkley-Black method, Available P (0.5 M $NaHCO_3$ extract) was analyzed by the method described by Olsen *et al*. (1954) and for total N a microKjeldahl method (Bremner and Mulvaney 1982) and soil dehydrogenase activity by Klien *et al.* (1971). Wheat was harvested in fourth week of April every year and grain yield was recorded while the straw was used for the preparation of compost in pits. In all the three years, there was no use of any chemical in form of fertilizers and as there was no infestation of pests no insecticide or pesticides were used. Whenever there was termite infestation, neem khali was applied and over flooding of plots was done.

RESULTS AND DISCUSSION

The soil pH was 7.8 (1: 2 soil/water suspension, w/w); organic C 0.25%, N 0.038%, P 45 kg/ha and soil dehydrogenase activity 46.079 microlitres $H_2\uparrow$ Vermicompost which was applied contained 1% N. Fig 1 shows that the organic carbon content of soil improved from 0.25% to 0.68% in three years. There was increase in carbon content in all the treatments, on comparing the results of first year, the treatment where vermicompost was applied along with PSB and AM fungi (T3) resulted in maximum amount of Walkley's organic carbon followed by vermicompost, *Azotobacter*, *Azospirillum* and AM fungi (T4). The trend in second year and third year was slightly different vermicompost along with *Azotobacter*, *Azospirillum* and AM fungi (T4) showed maximum amount of Walkley's organic carbon content. This shows vermicompost and all the microbial inoculants improved soil carbon content and helps in improving soil health.

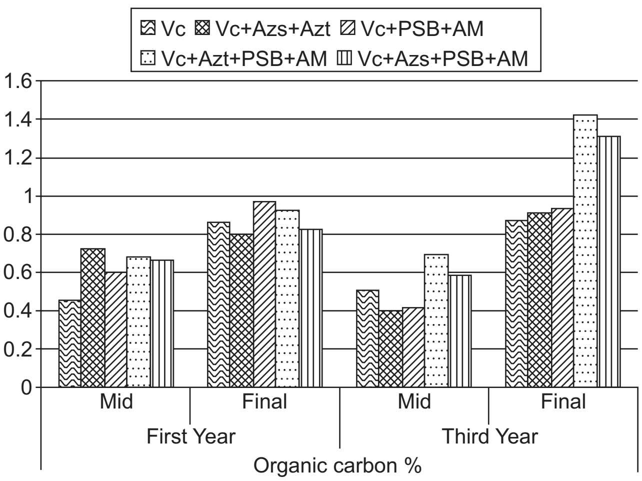

Fig 1

The use of nitrogen fixing biofertilisers *Azotobacter* and *Azospirillum* along with vermicompost also played a role in

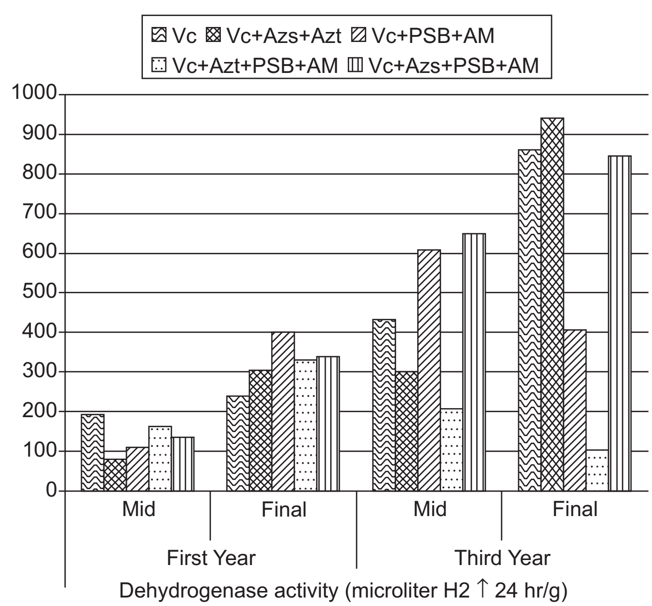

Fig 2

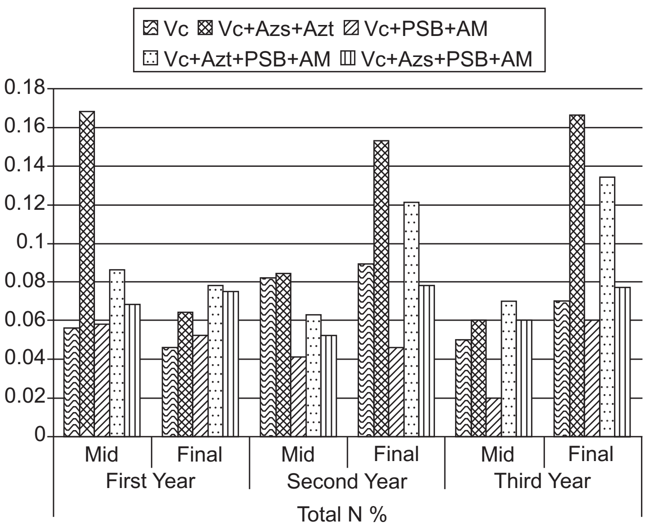

Fig 3

increasing soil N 0.038% from first year to 0.061% in third year. The results of Fig 2 highlights that the increase in N% was more where *Azotobacte*r and *Azospirillum* were applied while the other treatments showed less increase which clearly shows the role of these microbial inoculants in improving soil N%.

The treatments also improved the soil C: N ratio which increased from first year 7.0 to third year 11.1, and vermicompost along with PSB and AM fungi was the best treatment in all the three years (Fig 3). All the treatments improved available P content of the soil but the higher available P content was found in the treatments where PSB, a phosphate solubilising bacteria was applied along with vermicompost. Fig 4 clearly shows an increase in available P content in all the three years in T3, T4 and T5 respectively. Soil dehydrogenase is an indicator of active microflora and it also increased from 46.079 to 190.51 microlitres $H_2\uparrow$/24

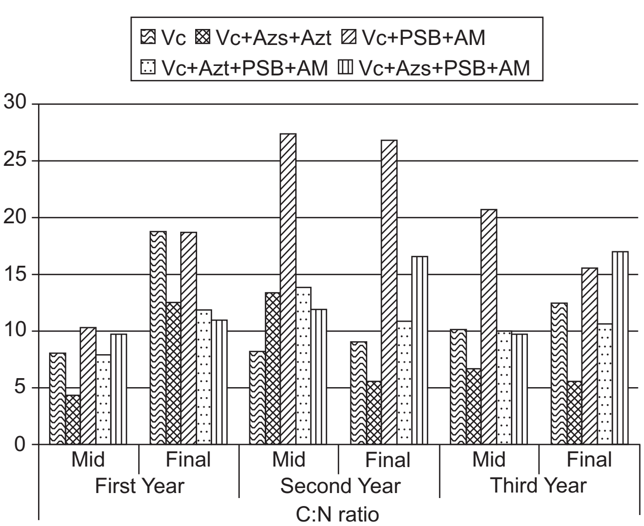

Fig 4

Table 1 Effect of vermicompost and microbial inoculants on thousand grain weight.

Treatment	1000 grain weight (g)		
	First year	Second year	Third year
Vc	33.460	35.160	37.164
Vc+Azs+Azt	35.020	35.351	36.619
Vc+PSB+VAM	33.700	34.950	36.378
Vc+Azt+PSB+VAM	34.409	36.525	38.370
Vc+Azs+PSB+VAM	36.113	36.864	38.444

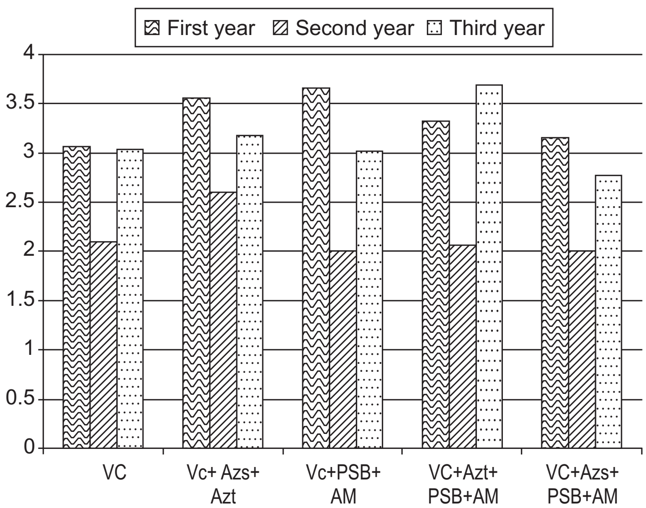

Fig 5 Effect of vermicompost and microbial inoculants and grain yield

hr/g from first year to third year and indicates the improvement in soil micro flora. The average yield data and 1000 grain weight as in Table 1 shows that vermicompost along with *Azospirillum* and *Azotobacter* gave maximum yield 3.11 tonnes/ha among all the treatments. The three years work indicated that both vermicompost and microbial inoculants can be applied for organic inputs and all the inoculants contribute for the crop in terms of yield as well as provides nutrients for further crops and improves soil health. The results of the study are coincident with Gaind and Lata (2007) who reported vermicompost fertilization resulted in highest microbial biomass, available phosphorus, and nitrogen content of wheat soil. Pramanik *et al*. (2007) studied application of lime and inoculation of microorganisms and reported increased nutrient content in vermicompost and also phosphatases activities. Pant *et al,* (2009) observed vermicompost teas enhanced plant production, mineral nutrients and total carotenoids. This effect was most prominent under organic fertilisation. Antioxidant activity and total phenolics were higher under organic compared with synthetic fertilisation.

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