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FULL LENGTH ARTICLE

# Chemical fertilizer in conjunction with biofertilizer and vermicompost induced changes in morpho-physiological and bio-chemical traits of mustard crop

**Tanushree Mondal** [*], **Jayanta Kumar Datta** [1], **Naba Kumar Mondal** [2]

*The University of Burdwan, Department of Environmental Science, Golapbag More, Post – Rajbati, Burdwan, West Bengal 713104, India*

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**Abstract** To study the impact of reduced dose of chemical fertilizer and its combination with biofertilizer and vermicompost on morpho-physiological and biochemical traits of mustard (*Brassica campestris* cv. $B_9$), field experiments were conducted during winter seasons of November to February 2011–2012 and 2012–2013 respectively in an old alluvial soil zone of Crop Research and Seed Multiplication Farm, Burdwan University, Burdwan, West Bengal, India. Mustard was cultivated using a full recommended dose of chemical fertilizer (N:P:K–100:50:50) and along with six different reduced doses of chemical fertilizer combined with biofertilizers and vermicompost. The performance of the crop was adjudged in terms of various parameters viz. leaf area index (LAI), leaf area duration (LAD), leaf area ratio (LAR), crop growth rate (CGR), net assimilation rate (NAR), photosynthetic rate (PR), harvest index (HI) and biochemical attributes such as total chlorophyll, sugar and proline content of physiologically active leaves of mustard. Differential significant ($p < 0.05$) treatment response was reflected for the studied traits during crop maturity. The data revealed that vermicompost application significantly stimulated most of the studied attributes. It was concluded that 25% reduced dose of chemical fertilizer and

* Corresponding author. Tel.: +91 8972219960.
E-mail addresses: tanus53@yahoo.com (T. Mondal), profjkdatta@yahoo.co.in (J.K. Datta), nkmenvbu@gmail.com (N.K. Mondal).
[1] Tel.: +91 94746348300.
[2] Tel.: +91 9434545694.

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its combination with vermicompost (T4) was optimum for most of the parameters studied as compared to the control at both crop stages.



## 1. Introduction

India is the third largest producer of oil seeds in the world. It accounts for 19% of world's area and 9% of the global production (Sinha, 2003). Mustard (*Brassica campestris*) is an important oil seed crop, next to sunflower. Application of chemical fertilizers has contributed significantly to the huge increase in the world food production. But the adverse impacts of excessive inputs of chemical fertilizers in conventional agricultural practices are being well documented (Banerjee et al., 2011; Garai et al., 2014). Chemical fertilizers also have contributed significantly toward the pollution of water, air and soil. In agro-ecosystems, the use of synthetic toxic chemical pesticides affects the soil fertility and growth of cultivated crops (Ignacimuthu and Vendan, 2007). At present we are using chemical fertilizers in great quantities to compensate the deficiency of nutrients in soil. For minimizing the accumulation of pollutants in agro-ecosystems we should avoid the use of toxic chemicals especially synthetic chemical pesticides and fertilizers in agricultural process. Organic products are eco-friendly natural sources, which can be considered as an alternative to sustainable agriculture development. In India, as a step toward the expansion of native sources, the application of organic waste materials will be useful for achieving higher production. The impact of organic agriculture on natural resources favors interactions within the agro-ecosystem that is vital for both agricultural production and nature conservation. The current trend is to explore the possibility of supplementing chemical fertilizers with organic ones that are eco-friendly and cost-effective.

In the above context, eco-friendly and environmentally safe biofertilizer, vermicompost, etc. became handy to minimize chemical fertilizer use as well as a carbon sink in such crop fields. In recent years, vermicomposting has turned out to be promising way out for safe disposal of organic waste. It is a technique of biodegradation or stabilization of organic waste (natural/anthropogenic) by using earthworms and microbes (Garg et al., 2006; Suthar, 2007; Mainoo et al., 2009). Earthworm plays a major role in plant material degradation and this concept is used in vermicomposting technology with the supplement of cow dung source to enhance plant growth. Cow dung is an organic and nitrogen rich material, and it can be easily degraded in the soil. Cow dung also exhibits plant growth promoter properties (Nattudurai et al., 2014).

The use of biological nitrogen fixation by living nitrogen fixers will help to minimize use of chemical nitrogen fertilizer and to improve plant growth to decrease the production cost and environmental risk (El-Hawary et al., 2002). Bacterial fertilization of non-legume crops by nitrogen fixing bacteria has assumed great importance in recent years. In our present investigation, phosphate solubilizing bacteria (PSB) and *Azotobacter* are used as biofertilizer. PSB secrete some organic acids which can solubilize P from insoluble and fixed forms to plant available forms, whereas *Azotobacter* can convert atmospheric $N_2$ into plant available form of N in the soil. In the recent years, among the various sources of organic manure, efficacy of vermicompost was reported manifold. Earthworms consume large quantities of organic matter and excrete it as cast and this cast contains several enzymes and is rich in plant nutrients, which are beneficial for bacteria and mycorrhizae (Reddy and Reddi, 2002). They also noted that vermicompost is an excellent base for the establishment of beneficial non-symbiotic and symbiotic microbes. Different levels of nitrogen significantly influenced LAI, total dry matter accumulation, CGR, but plant height was not significantly influenced by the different levels of nitrogen application. On the other hand, Stamp (2003) proposed that increased crop growth and development rates and greater biomass accumulation in well-fertilized crops would also correlate with decreased allocation of resources toward the production of starch, cellulose, and non-nitrogen-containing secondary metabolites, important group of bioactive compounds.

This study, therefore, was conducted to evaluate the effects of integrated nutrient management (chemical fertilizers, biofertilizer and vermicompost) on the morph-physiology and macromolecular changes in leaves of mustard (*B. campestris* cv. $B_9$) and to screen out the best fertilizer combination under this field condition.

## 2. Materials and methods

### 2.1. Experimental site

Field experiments were conducted at the Crop Research and Seed Multiplication Farm, Burdwan University, Burdwan, West Bengal, India. The latitude is 87°50′37.35″E and longitude is 23°15′7.29″N with an average altitude of 30 m above the mean sea level during the winter seasons of 2011–2012 and 2012–2013 with rapeseed (*B. campestris* L. cv. B9).

### 2.2. Climatic condition

Weekly minimum and maximum temperature, total rainfall, sunshine hours, wind speed, and relative humidity (RH) were recorded. Some climate factors were collected and analyzed. Climate factors in both growing periods were similar but not the same. Both the growth periods started with moderate temperature where the maximum temperature was around 29 °C and the minimum temperature was around 16 °C, and then they cooled and ended again with similar maximum and minimum temperatures. The mean temperature and high relative humidity (ranging between 75% and 90%) were similar for both growing cycles. The mean wind speed (1.3–8.1 km $h^{-1}$) and mean sunshine (4.23–7.15 h $day^{-1}$) were almost the same in both growing seasons. No rainfall was recorded in the first growing season (2011–2012), but in the second season 0–5 mm rainfall was recorded on average.

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