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Review Article

Effect of Vermicompost, FYM, Azotobacter and Inorganic Fertilizers on Production and Productivity of Wheat (*Triticum aestivum* L.) – A Review

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A B S T R A C T

The adequate and balanced supply of plant nutrients is of critical importance in improving the productivity of wheat crop. Due to prohibitive cost of chemical fertilizers, Indian farmers, mostly marginal and small, do not supply the recommended doses of nutrients to these energy rich crops, indigenously available organic sources of nutrients have been recorded to enhance the efficiency and reduce the requirement of chemical fertilizers. The basic objective of this review is to express nutrient supply and management is to make, as for as possible, balanced nutrient supply to crop that maintains the soil fertility and soil health and also sustained high productivity on a long-term basis, as plant nutrient source differ markedly in their nutrient contents, release efficiency or fixation, positional availability, crop specificity farmers acceptability etc.

Keywords

Wheat, Vermicompost, Fertilizers and Productivity

Introduction

Wheat (*Triticum aestivum* L.) is most staple and second most important crop after Rice, of the country which contributes nearly one third of the total food grain production. It is consumed mostly in the form of bread as “Chapatti”. Wheat straw is used for feeding the cattle. Wheat contains more protein than other cereals and has a relatively high content of Niacin and Thiamine. It is basically concerned in providing the characteristics substance “Gluten” which is very essential for bakery. The common bread wheat occupies more than 90% of the total wheat area along with 10% area under *Triticum durum.* Its cultivation is common under rainfed condition only a large area has come in Punjab under irrigated condition due to high yielding varieties developed to obtain the foreign exchange. Wheat is a very adoptable crop and is grown under a wide range of soil and climatic condition.

The crop is most successfully grown between latitudes of 30^0 N to 60^0 N and 27^0 S to 40^0 S in the world, with a high altitude of 5000 m. In India, wheat is grown from 11^0 N to 30^0 N and from sea level up to an elevation of 3658 m in the Himalayas. In India it is grown mostly in the plains where as in the hills it is cultivated in mountainous regions of North

India under a wide range of climatic conditions from Kashmir and other mountainous region to semiarid regions with mild to severe winter.

Wheat varieties developed for broad-acre agriculture were traditionally tall plants with a long straw that was also used extensively for animal feeding or thatching. However, with that came the downside of the plants being unstable, particularly in dry, sandy soils, and subject to ‘lodging’ where in windy conditions, whole sections of the crop would lay down, making it difficult to harvest. The problem was largely solved by the introduction of semi dwarfing genes into wheat genomes. A Japanese dwarf wheat cultivar ‘Norin 10’ was the primary source and the resultant short-strawed and much more stable varieties contributed to improved wheat yields worldwide.

These have been credited with being one of the main factors in the ‘Green Revolution,’ the phenomenon whereby cereal production more than doubled in many developing countries between the years 1961 and 1985.

These production increases can be attributed roughly equally to irrigation, fertilizer, and seed improvements, and the overall impact of the Green Revolution on global food security is the subject of much debate.

The world population has grown by about 4 billion since the beginning of the Green Revolution, and India saw an annual wheat production rise from 10 million tonnes in the 1960s to 73 million in 2006. Between 1950 and 1984, as the Green Revolution transformed agriculture around the globe, world grain production increased by over 250%, and these production increases are often credited with having helped to avoid widespread famine and feeding billions of people.

Effect of different treatments on production and productivity of wheat

Effect of FYM on production and productivity of wheat

Chaudhary *et al.*, (2001) reported that the highest grain yields were obtained with N at 90 kg ha^{-1} (3877 kg ha^{-1}) and 120 kg ha^{-1}(3871 kg ha^{-1}) + FYM on late sown wheat. Whereas Singh and Agarwal (2001) reported that the plant height dry matter accumulation, effective tillers, grains per spike, grain straw and biological yield increased significantly with the graded levels of FYM up to 20 t ha^{-1}, but the response decreased with the increase of FYM from 20 to 30 t ha^{-1}.The interaction effect was found to best non-significant by Ananda and Patil (2005) revealed that the time of N application on growth and yield of durum wheat. Data on grain and straw yield differed significantly both due to micronutrients and time of Nitrogen application. Among the different time of Nitrogen application tested nitrogen applied in three splits i.e., ½ basal + ½ 30 DAS + ¼.60 DAS and <<basal + 1/3 30 DAS +1/3 60 DAS recorded significantly higher grain yield (41.44 and 40.96 q/ha respectively) as compared to nitrogen applied in two splits. i.e., 1/2 basal + 1/2 30 DAS (38.91 q/ha).

Effect of vermicompost on production and productivity of wheat

In an investigation at HisarRanwa and Singh (1999)reported that application of vermicompost at the rate of 10 t ha-1 was at par with 7.5 t ha-1 in number of effective tillers, length of ear, number of grains per spike, grain weight per spike, grain and straw yield of wheat but these were significantly higher with repats to application of vermicompost @ 5 t ha. Though Paliwal, Kushwaha, Thakur (2006)exposed that the incorporation of vermicompost @ 5 t/ha with

25% decrease in suggested dose of fertilizers in both the crops lead to significantly higher yield attributes and yield of both crops. Ridge and furrow planting of soybean followed by Gliricidia leaves mulch in wheat increased the system yield by 11.96%. Total cropping system yield (6.98 t/ha), net return (Rupee 60,985/ha) and benefit: cost ratio (2.31) in system were recorded under the combination of broad bed furrow in both crops and use of vermicompost @5t/hain soybean along with 75% RDF in both crops. The application of vermicompost @ 3.8 t ha-1 and poultry manure @ 2.4 t ha-1 recorded significantly higher plant height (86.30 cm), and higher number of tillers (94.60) per square metre at 90 DAS and also recorded higher test weight (42.73 g), seed yield (3043 kg ha-1), and protein content (13.41%) as compared to other treatments in wheat crops Channabasana *et al.,* (2002).

Effect of nitrogen on production and productivity of wheat

Study from Ludhiana, Punjab reported that all yield attributes increased with increasing nitrogen rate except 1000 grain weight in 1998-99, nitrogen at 150, 180 and 210 kg/ha resulted significantly higher grain yield over 120, 150 and 180 kg/ha was superior over to 210 kg N/ha Kaur *et al.,* (2001). Similar study on effect of nitrogen on production and productivity of wheat was done by Maqsood and Ali (2002)he observed that the application of N increased the yield and yield attributes of wheat, giving the highest no. of productivity tillers (871.73 m^2), number of grains per spike (44.28), 1000 grain weight (36.57 gm) when N was applied @ 160 kg ha^{-1}.Whereas alike outcome of nitrogen on wheat production was done by Sharma and Manohar (2002) reported that application of 120 kg N/ha enhanced the grain and straw yield of wheat by 63.5 and 30.1% respectively over 30 kg N/ha. A parallel trend was observed by Shukla *et al.,* (2006) an experiment was directed at Faizabad (U.P.) during *rabi* season were observed that the extreme grain yield of 38.48 and 40.28 q/ha was obtained with 180 kg N/ha which was at par with 150 kg N/ha (37.85 and 37.54 q/ha) and significantly higher than that of 120 kg N/ha (32.94 and 34.57 q/ha) during 1999-2000 and 2000-2001 respectively. A similar trend was also observed for straw yield. Number of ear heads/m^2 increased with increasing nitrogen up to 180 kg N/ha. One more study in 2006 also conducted at Faizabad now Ayodhya by Singh and Yadav (2006)they concluded that application of 150 kg N/ha increase the yield attributes and yield of wheat if increased the grain yield by 96.6, 65.0 and 37.7% compared to 0, 50 and 100 kg N/ha.

Effect of phosphorus on production and productivity of wheat

Phosphorus is vigorous for plant development starting when wheat is just seedling. Above and beyond it plays a role in the quality and formation of seeds, this nutrient helps ensure uniform heading, faster maturity and strengthens the plant to help survive the winter. To observe the effect of phosphorus Rana *et al.,* (1978) conducted the experiment and observed that application of 90 kg P_2O_5 ha^{-1} increased the grain yield of wheat from 3.48 t ha^{-1} to 4.42 to ha^{-1} as compared to control. By way of phosphorus strengthens the plant to help survive the winter that's why Vnuk *et al.,* (1995) conducted a trial on winter wheat cv. He states that P and K rates and obtained grain yield of 8 t ha^{-1}. In one treatment given an additional 30 kg N with basic application of P and K grain yield were 5.94 t ha^{-1} without fertilizer and 6.4 – 6.69 t ha^{-1} with fertilizer. Another study was done to see the effect of nitrogen on wheat production by Ali *et al.,* (2004) he Experiential that dry matter yield of wheat at maximum at tillering stage grain and straw were significantly increased due to combined application of S and P (S_{40}, P_{35}). This combination increased 20% higher dry matter 61.1% higher grain yield and 65.1% higher straw at treatment combination of S_{40} + $P_{35.}$To see the interaction between the phosphorus and Sulphura experiment conducted by Islam *et al.,* (2006)and he reported that the concentration of P and S were increased with increasing dose of P and S in wheat and rice plants using three level of P (0, 17.6, 35.2 kg ha^{-1}) for each crop and three level of sulphur (0, 20 and 40 kg ha^{-1}). The interaction between P and S resulted the antagonistic effect on P concentration in wheat and rice plant when P and S were applied at higher concentration. The highest grain yield of rice was obtained with the application of 17.6kg P + 20 Kg S $ha^{-1.}$Another study conducted at PAU Research farm by Brar *et al.,* (2009)shows that by increasing the dose of phosphorus additional grain yield to the tune of 2.7 and 3.2 qha^{-1} were achieved at PAU Farm and farmers field respectively. A positive impact of application of Phosphorus byKhan *et al.,* (2011)he stated that the maximum growth and yield wheat was recorded at 120 kg ha^{-1} P_2O_5 application.

Effect of potassium on yield attributes and yield of wheat

Wheat needs potassium for optimum growth and development. Satisfactory potassium results in superior quality of the whole plant due to improved efficiency of photosynthesis, improved resistance to some diseases, and better water use efficiency and several studies also evidenced this statement Rana *et al.,* (1978) observed that application of 90 kg P_2O_5 ha^{-1} increased the grain yield of wheat from 3.48 t ha^{-1} to 4.42 to ha^{-1} as compared to control. Another study by Pandey *et al.,* (2004) showed significant effect on growth characters *viz.* height of plant and number of tillers per plant at different growth stages and number of grains per ear and test weight of 1000 gain of harvest with addition of K. The yield significantly increased with increasing levels of potassium up to 60 kg K_2O ha^{-1}. The grain yield significantly increased due to application of potassium up to K-90 treatment and further it decreased with increased in level of KPolara *et al.,* (2010) he conducted a field experiment under field condition and studied the effect of K (K0, K16, K90 and K120 kg/ha) on grain yield, dry weight of root, root volume, total root length.

Effect of Azotobacter on production and productivity of wheat

Azotobacter improves seed germination and has beneficiary response on Crop Growth Rate (CGR). It helps to increase nutrient availability and to restore soil fertility for better crop response. It is an important component of integrated nutrient management system due to its significant role in soil sustainability. Essam A. Abd El-Lattief (2016) Azotobacter and Azospirillium genera are free living bacteria and fix atmospheric nitrogen in cereal crops without any symbiosis. They fix 30-40 kg ha nitrogen per year. Azotobacter sp. Also has ability to produce antifungal compounds against many plant pathogens. Thus, biofertilizers containing beneficial organisms are cost effective, pollution free and perennially renewable source of plant nutrients, making them ideal partners and essential supplements to chemical fertilizers. Kumar and Narula (1999) studied on three wheat varieties viz. C-306, WH-542 and HD-2009, showed that better performance of wheat to inoculated with Azotobacter. Application of bioinoculant had a positive effect on plant height peduncle length grain yield significantly Singh *et al.,* (2004) his study was conducted Hisar, Haryana, India to investigate the effect of bioinoculants in low inputs fields conditions. Another study was observed by Ravindra Kumar and Samir Pal (2010)he revealedthat the treatments consisted of Azotobacter, phosphate solubilizing bacteria (PSB), blue-green algae (BGA), rice residue incorporation and NPK fertilizers. Significantly higher yields to the tune of 4.3 t ha-1 for rice and 4.0 t ha-1 for wheat were recorded when rice-wheat were grown after green manuring of dhaincha in-situ or application of FYM (10 t ha-1 year-1).

Combined Effect of organic and inorganic fertilizers on production and productivity of wheat

The rapid increase in the world population demands parallel increases in food production, particularly of wheat. In order to preserve the environment and the present natural resources, further increases in global wheat production must be along with a proper management of fertilization. Integrated use of organic wastes and chemical fertilizers is beneficial in improving crop yield, soil pH, organic carbon and available N, P and K in soil.

Effect of NPK

Dhonde and Bhakare (2008) reported that the incorporation of FYM, wheat straw, glyricidia leaves for 25-50% N substitution in conjunction with balance dose of NPK fertilizers increase the organic matter 1.10 to 1.27 percent and bulk density decreased from 1.32 to 1.22 mg m^{-3}. The soil reaction and electrical conductivity remain unaffected while the organic carbon content increased appreciably and ranged from 0.68 to 0.74 percent. The available N, P_2O_5 and K_2O improve after the harvest of wheat crop. Similar results were obtained by Rathare and Sharma (2010) observed that the maximum fertility status in terms of available N, P, K and Zn after the harvest of wheat crop as (231.0, 18.5, 130.6 kg ha^{-1} and 1.64 mg kg^{-1} respectively.

Effect of NPK + FYM

Bhakar *et al.*, (1997) reported that application of 15 t FYM ha-1 gave significant higher number of total tillers, effective tillers and grain per ear of barley over no FYM and 5 t FYM ha-1 but was at par with 10 t FYM. Another study was conducted by Singh *et al.*, (2010)observed that 10 t ha^{-1} FYM + 75 % NPK +$ZnSO_4$ significantly increased plant height, number of effective tillers, spike length, number of grain ear^{-1}, test weight, grain yield, straw yield and protein content as well as NPK content and uptake in grain and straw of wheat, respectively over 100 % RDF. Highest grain yields were obtained with N at 90 kg ha^{-1} (3877 kg ha^{-1}) and 120 kg ha^{-1} (3871 kg ha^{-1}) + FYM on late sown wheat reported by Chaudhary *et al.*, (2001). Another study by Kumar and Singh (2010) carried out trial on rabi season and found significantly grain and straw yield of wheat crop were recorded with application of 100% RDF+ 10t FYM ha-1+PSB.Highest values of previous traits were obtained from treatment T4 (50% chemical NPK + 6 tons FYM per ha). Also, this treatment gave the maximum return and net profit per ha compared with the other treatments reported by Essam A. Abd El-Lattief (2014). Therefore, integrated plant nutrient supply system could help in meeting the goals of balanced fertilization and reduce environmental pollution.

Effect of NPK + Vermicompost + Azotobacter

The application of Azotobacter and PSB along with FYM or vermicompost or green manuring. Application of BGA in paddy and incorporation of rice residue before sowing of wheat further reduced the recommended dose of N fertilizer by 30 kg ha-1 for both rice and wheat. Cultivation of rice and wheat on the recommended dose of NPK fertilizers alone decreased the organic carbon, available P and K content of the soil.

Application of FYM, vermicompost, green manuring, and rice residue incorporation alone or in combination with biofertilizers supplemented by NPK fertilizers improved the soil fertility besides maintaining higher sustainable productivity Elkholy Mahrous (2011). Another field experiment was conducted during the winter season (rabi) of 2004-05 at Allahabad Agricultural Institute-Deemed University, Allahabad to study the effect of biofertilizers with nitrogen levels on growth, productivity and economics of wheat (*Triticum aestivum*).

Seed inoculation by *Azospirillum brasilense* or *Azotobacter chroococcum* strains with nitrogen levels significantly influenced the growth attributes, yield attributes and yield of wheat.

Use of 75% recommended dose of N along with *Azospirillum* or *Azotobacter* seed inoculation showed at par results when compared with 100% recommended nitrogen (120 kg/ha) towards growth attributes (plant height and dry weight), yield attributes (number of effective tillers/plant and number of grains/panicle) and yield.

Slightly higher net return and benefit cost ratio were achieved but actual grain yield, straw yield and test weight which was slightly higher from 100% recommended dose of N. In sandy loam soils, seed inoculation with Azospirillum or Azotobacter strains supplemented 25% of recommended dose of nitrogen (25 kg N/ha) in wheat which reduced the use of inorganic fertilizers with a view to attain an eco-friendly environment Zade *et al.,(2008).*

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