Review on effect of conjunctive use of organic manures and inorganic phosphorus on growth, yield attributes, yield and economics of rice

I Jagga Rao, Ch Sujani Rao, PRK Prasad, Ch Pulla Rao and K Jayalalitha

Abstract

Among several management practices that affect soil quality, fertilizer application is of paramount importance for its role in growth and development of the crop. In intensive agriculture with high yielding varieties, crop yields have adverse effect on physical properties of soil such as bulk density, water holding capacity. In spite of increased cost of fertilizer and their adverse effect on soil and environment the best alternative sources for plant nutrients to be explored to meet partial or full requirement of crop. Hence, it is time to pay serious attention to nutrient management. The integrated use of organic manures and inorganic fertilizers can help to maintain optimum crop yields and long term soil productivity.

Keywords: organic manures, phosphorus fertilizers, growth and yield

Introduction

Rice (Oryza sativa L.) is the staple food crop for the world billions of people. It plays a vital role in our national food security, hence, the slogan ‘Rice is Life’ is most appropriate. Rice stands second in the world after wheat in area and production. India occupies a pride place in rice production among the food crops cultivated in the world. About 90 per cent of rice grown in the world is produced and consumed in Asian countries, China and India accounting for more than half of the world’s acreage. In India, it is grown in an area of 43.9 m.ha with a production of 2637 tonnes mha$^{-1}$ [12]. In Andhra Pradesh, it is grown in an area of 2.152 m.ha with a production of 8.05 tonnes mha$^{-1}$ with a production of 3741 kg ha$^{-1}$. (Ministry of Agriculture, Govt of India, 2018-19). Although the fertilizers are very effective in increasing yield, they may deteriorate the soil health and pollute the ground water. In addition, chemical fertilizers are expensive due to the energy crisis and are unavailable to many farmers, particularly in developing countries like India. There is vast scope for increasing nutrient supply through use of organic manures and adoption of proper cropping system, which together can contribute significantly to the required nutrient pool. In this situation, conjunctive use of organic manures and inorganic source of phosphorus fertilizers can improved the source of plant nutrition, it results in increased soil fertility.

Phosphorus is the second essential plant nutrient required by plant in large quantity next to nitrogen by rice crop is more compared to other crops. Phosphorus not only enhances the yield, it is the primary constituent of plant and animal life. P always plays a vital role in several metabolic processes. It has structural function in macromolecules, metabolic pathways and degradation. It is involved in a wide range of plant processes starting from permitting cell division to the development of a good root system, ensuring timely and uniform ripening of the crop. It is needed mostly by young, fast growing tissues and performs a number of functions related to growth, development, photosynthesis and utilization of carbohydrates. It is a constituent of ADP and ATP, two of the most important substances in life processes. But the main problem concerning phosphatic fertilizers is its fixation with soil complex within a short period of application rendering more than two thirds unavailable. So, it is necessary to know the optimum dose of phosphorus fertilizer for maximum yield. Phosphorus fertilization is required to sustain optimum crop yields (Pypers et al., 2005; Nachimuthu et al., 2009) [20, 11].

Growth

Indrani et al. (2008) [7] found that incorporation of green manure through Gmelina arborea with inorganic fertilizer recorded higher plant height (71.1 cm) and tillers m$^{-2}$ (85) than fertilizer applied alone on sandy loam soils of Jorhat, Assam. Karmakar et al. (2011) [12] stated that application of 50% NPK through inorganic fertilizer along with 25% N FYM + green
manure+ BGA recorded the highest plant height (81.48 cm) on sandy loam soil of Ranchi. The highest plant height (77.60 cm) and root biomass (826.77 kg ha⁻¹) was recorded with combined application of NPK + chromolaena compost at Mandya, Karnataka (Krishna Murthy, 2012) [13], Islam et al. (2014) [14] reported that the tallest plant (94.21 cm), maximum number of effective tillers hill⁻¹ (14.73), longest panicle (24.42 cm), maximum grains panicle⁻¹ (84.80), maximum 1000 grain weight (23.08 g) and maximum grain yield (5752 kg ha⁻¹) and straw yield (6654 kg ha⁻¹) were recorded by incorporation of green manure at 30 days after sowing with 75% RDN (180:120:70 kg ha⁻¹). The highest plant height (128.4 cm) and more number of tillers (521) were recorded by combined application of NPKs & Zn @ 120:60:60:40 &5 kg ha⁻¹ with FYM at Kanpur (Manoj Parihar et al., 2015) [15], Venkata lakshmi and Veeraraghavaiah (2015) [16] reported that incorporation of Glyricidia with 240 Kg N ha⁻¹ recorded the highest plant height (93.2 and 86.2 cm), maximum number of tillers (490 and 470) and highest drymatter accumulation (4257 and 3976 kg ha⁻¹) during 2008 and 2009 on sandy clay loam soil at Agricultural college Farm, Bapatla. Geetha and Balasubramaniyan (2016) [17] observed that combined application of 50% RDF+6.25 t of green manure (Sesbania aculeate) recorded the highest plant height both in panicle initiation stage (116.7 cm) and harvesting stage (130.3 cm) on sandy loam soils of Madurai, Tamilnadu. Application of green manure in combination with 120 kg ha⁻¹ recorded the highest plant height (84.30 cm) and maximum number of tillers m⁻² (733) at Agricultural College Farm, Bapatla, Andhra Pradesh (Sujatha et al., 2016) [18]. Kyaw Lin Thu et al. (2017) [19] reported that the highest plant height (89.3 and 77.26 cm) was recorded during 2015 and 2016 by the combined application of NPK @ 43:15:26 with poultry manure were recorded Letkhoke Pin village in Myanmar.

Yield attributes and yield
Ashutosh Shrivastava et al. (2006) [2] conducted an experiment on clay loam soils of Indira Gandhi Agricultural University, Raipur and reported that combined application of 50% RDF+50% N through summercotton significantly recorded the higher number of grains/ panicle (122), maximum number of fertile grains panicle⁻¹ (112.4), highest panicle length (23.2 cm), highest grain yield (6.5 t ha⁻¹) and straw yield (7.6 t ha⁻¹) of rice. Bajpai et al. (2006) [20] found that the highest grain yield (60.51 q ha⁻¹) was recorded with 50% N through Sesbania aculeata and 25% N through fertilizer (80:60:40) at Raipur. Stalin et al. (2006) [21] recorded higher grain yield (5403 kg ha⁻¹) of rice by combined application of inorganic fertilizer along with green manure over NPK alone (5018 kg ha⁻¹). Balwinder Kumar et al. (2008) [22] reported that highest grain yield of rice (6.71 t ha⁻¹) was recorded by the combined application of 100% NPK+FYM at Punjab Agricultural University, Ludhiana. The highest grain yield of rice (4.48 t ha⁻¹) was recorded when rice was grown after green manuring of dhaincha in situ along with 60:13:37 kg of NPK fertilizer ha⁻¹ (Fatesh Singh et al., 2008) [23]. Rakesh Sahu et al. (2009) [24] reported that the highest grain yield (3833 kg ha⁻¹) was recorded with the combined application of N, P, K, and Zn @ 80, 12.5, 40, 93 and 7 with three irrigations at Jabalpur. Karmakar et al. (2011) [25] stated that the significantly maximum panicle length (23 cm) and more number of grains panicle⁻¹ (113), highest grain yield (4.33 t ha⁻¹) and straw yield (5.99 t ha⁻¹) of rice were obtained in 50% RDF+25% N FYM + green manure + BGA on sandy loam soil of Ranchi. Singh and Dolly Dhar, (2011) [26] reported significant enhancement in grain yield of rice over absolute control (N0 P0 K0) due to application of different organic sources of nutrients applied in combination with fertilizers in sandy clay loam soil of New Delhi. Rice crop grown after green manuring with Glyricidia (10 t ha⁻¹) along with 100% of the recommended dose of N, P and K also improved the grain, straw and biological yields of rice at Parbhani, Maharashtra (Yadav and Raskar, 2011) [13]. Krishna Murthy (2012) [13] observed that the highest number of grains/panicle (131), 1000 grain weight (24.88 g), grain yield (48.66 q ha⁻¹) and straw yield 55.63 q ha⁻¹ of rice were recorded with combined application of NPK +chromolaena compost at Mandya, Karnataka. Mukesh kumar et al. (2012) [27] noticed that incorporation of Sesbania aculeata in sandy loam soil of Karnal in combination with 120 kg N and 26 kg P₂O₅ increased the number of tillers per m², test weight, grain and straw yields of rice. Titha Das et al. (2012) [28] on silty clay loam soil of Panthnagar noticed that combined application of FYM @ 15 t ha⁻¹+ NPK @120:26:33 kg ha⁻¹ recorded highest grain (44.83 q ha⁻¹) and straw yield (48.76 q ha⁻¹) of rice. The highest grain yield (6.26 t ha⁻¹) of rice was recorded due to the application of NPK @ 120:26:42 along with green manure on sandy loam soil of Karnal (Yaduvanshi et al., 2013) [29], Upadhyay and Vishwakarma (2014) [30] conducted an experiment at Jabalpur and reported that the application of 50% NPK with green leaf manure recorded the highest grain yield of rice. Manoj Parihar et al. (2015) [15] noticed that the highest grain (60.32 kg ha⁻¹) and straw yield (73.69 kg ha⁻¹) was recorded by combined application of NPKs & Zn @ 120:60:60:40 &5 kg ha⁻¹ with FYM at Kanpur. Venkata lakshmi and Veeraraghavaiah (2015) [13] conducted an experiment on sandy clay loam soil at Agricultural College Farm, Bapatla stated that incorporation of Glyricidia with 240 kg N ha⁻¹ significantly increased all the yield attributes like number of effective tillers, number of grains/ panicle, test weight, grain and straw yields of rice. Geetha and Balasubramaniyan (2016) [16] found that combined application of green manure (Sesbania aculeata) @6.25 t ha⁻¹ + leaf colour chart based N management recorded the highest panicle length (26.1 cm), number of panicles m⁻² (465), test weight (13.88 g) and grain yield (2100 kg ha⁻¹) of rice on sandy loam soil of Madurai, Tamil Nadu. Jana et al. (2016) [31] stated that incorporation of dhaincha @ 6 t ha⁻¹ + FYM @ 5 t ha⁻¹ along with NPK @ 50:25:25 kg ha⁻¹ significantly recorded the highest grain and straw yields (3.19 and 5.39 kg ha⁻¹) of rice on clayey soil of West Bengal. Sujatha et al. (2016) [32] conducted an experiment at Agricultural College Farm, Bapatla, Andhra Pradesh, reported that the highest number of tillers m⁻², maximum number of grains panicle⁻¹, highest number of filled grains panicle⁻¹, maximum test weight, maximum grain yield and straw yield of rice. Jaffar Basha et al. (2017) [9] found that significantly highest grain yield (4262 kg ha⁻¹) and straw yield (6033 kg ha⁻¹) was observed with the combined application of 100:50:50 kg NPK ha⁻¹+FYM+microbial consortium on clay soil of Dhawad, Karnataka. Similarly, Kyaw Lin Thu et al. (2017) [21] reported that the maximum number of panicles hill⁻¹ (10.4 and 12.7), maximum number of spikelets panicle⁻¹ (118.5 and 99.8), maximum test weight (22.6 and 22.3 g) and the highest grain yield (5.9and 6.3 t ha⁻¹) by the combined application of NPK @ 43:15:26 with poultry manure were recorded at Letkhoke Pin village in Myanmar.

Economics
Parasuraman et al. (2004) [19] reported that maximum net
returns and B:C ratio of Rs.5095 and 1.5 1 were obtained with 40 kg P₂O₅ ha⁻¹ as DAP against Rs.2508 and 1.00 in control and Rs.3686 and 1.23 with the existing blanket recommendation of 20 kg P₂O₅ ha⁻¹ as DAP. It is brought out that by applying 40 kg P₂O₅ ha⁻¹ as DAP paves the way for an additional income of Rs.1409 ha⁻¹ in rainfed sorghum in the red loamy sandy soil. Bajpai et al. (2006) [1] found that the highest net returns (28,076 Rs. ha⁻¹) were recorded with 50% N through Sesbania aculeata and 25% N through fertilizer (80:60:40) at Raipur. Sing et al., (2006) [2] reported that green manuring with NPK fertilizer gave the highest net return and benefit cost: ratio and produce significant higher biomass in returns of rice-equivalent yield. The highest net return (34582 Rs. ha⁻¹) of rice was recorded by the combined application of 100% NPK @ 120:60:60 kg ha⁻¹ with FYM at Bichpuri, Agra (Vinay Singh, 2006) [3] Jayadeva (2008) [11] reported that in-situ incorporation of green manure (Sunnhemp) + recommended NPK (125:62.5:62.5 kg ha⁻¹) recorded higher net income (Rs.42,636 ha⁻¹) and B:C ratio. Roy et al. (2008) [24] studied that application of 50% RDF (60-30-30 kg N-P₂O₅-K₂O ha⁻¹)+khaincha @ 10 t ha⁻¹ in rice provided highest gross return and net return in comparison to rice-oats, rice-fenugreek and rice-lathyrus systems. Ramesh Babu et al. (2009) [22] noticed the highest benefit cost ratio with the application of phosphate rich organic manure made of recommended dose of P₂O₅ in 1:4 ratio followed by phosphate rich organic manure made of double recommended dose of P₂O₅ in 1:4 ratios. Rani et al. (2009) [23] reported that net returns over variable cost from rice were Rs. 32,745 and 33,963 in cowpea green manuring and chemical fertilizers, respectively. The benefit/Rupees invested was highest in chemical fertilizer (Rs. 12.84) compared to cowpea green manure (Rs.8.22 to 8.60). Anitha and Jose Mathew (2010) [1] stated that green manuring with inter cropped dhaincha enhanced rice yield by 544 kg ha⁻¹ and returns by Rs.10,220 ha⁻¹ in sandy loam soil of Thrissur, Kerala. Karmakar et al. (2011) [12] revealed that the highest gross returns (40108 Rs. ha⁻¹), net returns (22,160 Rs. ha⁻¹) and benefit cost ratio (2.23) of rice with the application of 50% NPK through inorganic fertilizer along with 25% N FYM + green manure + BGA at Ranchi. On the other hand, Krishna Murthy (2012) [13] noted that the highest gross returns (56,662 Rs. ha⁻¹) and net returns (39,957Rs. ha⁻¹) of rice were recorded with combined application of NPK +chromolaena compost at Mandaya, Karnataka. However, Sujatha et al. (2016) [28] noted that application of green manure in combination with 120 kg K₂O ha⁻¹ recorded the highest gross returns (1,51,992 Rs. ha⁻¹), net returns (1,08,076 Rs. ha⁻¹) and benefit cost ratio (2.44) of rice at Agricultural College farm, Bapatla, Andhra Pradesh.

References


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