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Farmers' Participatory On-farm Testing (FP-OFT) of Organic and Conventional Systems on Productivity, Soil and Grain Quality of Aromatic Rice in India

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Since last few years organic cultivation of aromatic (Basmati) rice has taken a momentum in India because of higher premium price and preference in international market.Basmati rice is the leading aromatic fine quality rice of the world trade and it fetches good export price in the international markets. Basmati rice has characteristic like long-grain, subtle aroma and delicious taste and is one of the major agricultural commodities the country exports every year to earn foreign exchange. India is the largest producer and exporter of Basmati rice in the world, around 2/3rd is exported and remaining is consumed, within the country. Due to favorable geographical conditions available exclusively in northern India, Basmati rice grown in this region has got geographical indicator (GI) tag also. With this background, afarmers' participatory researchwas conducted to study the productivity, soil and grain quality and carbon dynamics in organic farming (OF) *via-a-vis* integrated nutrient management (INM) and mineral fertilized (MF) production system.

A farmers' participatory on-farm testing (FP-OFT) was conducted in two villages of Uttar Pradesh (UP), India during 2020-2022 involving 8 farmers. Farmers of the study group were fallowing basmati rice-vegetable cropping system. Three crop nutrient practices *viz.* organic, integrated nutrient management (INM) and chemical fertilization were taken in rice as well as vegetable crops. In organic crop nutrition four organic inputs *viz*. Blue Green Algae (BGA), *Azolla*, Vermicompost and farmyard manure (FYM) were applied in rice. In integrated nutrient management (INM), FYM was supplemented with urea, di-ammonium phosphate (DAP) and muriate of potash (MOP) in 25: 75 ratiowhereas in mineral fertilized (MF) system mineral fertilizers like urea, di-ammonium phosphate (DAP) and muriate of potash (MOP) were used to provide recommended dose of nutrients ($N_{120}P_{60}K_{60}$). For crop protection farmers applied FYM enriched with *Trichoderma* @ 2 kg ha^{-1}. Besides, need based spraying of Sudocel (*Pseudomonas* formulation) and Trichoel (*Trichoderma* formulation) both at 2% along with Neem oil (3000 ppm) was done @ 2%. Application of Biotercel (consortium of entomopathogenic fungi) and soil augmentation with neem cake at 125 kg ha^{-1} was also done for plant protection.Egg parasitoid *Trichogrammachilonis*@1, 20,000 ha^{-1} (1 card= 20,000 eggs) were released. Fixing of spider net and pheromone traps with lure @ 5 ha^{-1} was done to control yellow stem borer and leaf folder. In conventional method farmers' managed insect pest and disease of rice through chemical pesticides. For protection from bacterial leaf blight (BLB) farmers applied hexaconazole @ 300 ml ha^{-1}and tricyclazole @ 120 gm ha^{-1}. Carbendazim (50 WP) was applied for control of sheath blight @ 1.35 kg a.i ha^{-1}and for control of stem borer and leaf folder pesticides like Chlorpyriphos @1.0 L a.i ha^{-1}, Cartap hydrochloride@ 5-7.5 kg a.i ha^{-1}, Imidachlorprid @100 ml a.i ha^{-1} and Fipronil @ 5 kg a.i ha^{-1} were applied as and when needed and in majority of the cases rate of application of pesticides was higher than the recommended doses. For data on productivity, grain yield data were taken from a net plot area of 100 m^2. For estimation of grain quality and soil health parameters standard protocols were followed.

FP-OFT results showed that the rice grain yield under organic farming *i.e.* application of four organic inoculants (BGA, *Azolla*, Vermicompost and FYM) was the highest in all the farmers' fields followed by the yield under INM and mineral fertilization. Organic system proved to be beneficial for farmers as it gave higher net return than the conventional system. Farmers growing organic rice got around 25% higher price than conventional rice so they could get higher revenue of their produce. The net return under OF varied between INR 107550 to 145655 ha^{-1} (1 US Dollar = 80 INR) while in conventional farming it ranged between INR 50458 to 85674 ha^{-1}. The same trend was observed in cost benefit ratio. Singh *et al.* (2007) also found higher net returns of rice under OF than inorganic fertilization. Ramesh *etal*. (2010) revealed that under organic farming, inspite of the reduction in crop productivity by 9.2%, net profit to farmers was higher by 22.0% compared to conventional farming. Higher returns under OF was mainly due to the availability of premium price (20–40%) for the certified organic produce and reduction in the cost of cultivation by 11.7%.

Micronutrients (Fe, Zn, Mn) concentrations in rice grain enhanced significantly due to OF over INM and MF. Physical properties of soil *viz*. field capacity, available water content and water retention capacity of soil improved with organic management. Higher amount of soil organic carbon (SOC) was observed in organic treatment as compared to inorganic treatment. Microbial biomass carbon was highest under organic treatment followed by INM and MF. SOC content of soil improved in organically fertilized soil compared to INF and MF. OF practices affected grain elongation and length: breadth ratio. Mean values of KL: KB increased from 3.94 (before cooking) to 6.19 (after cooking) in organic fields whereas this increment was from 3.71 to 5.82 in case of MF. Grain elongation was higher in organic fields (191.5%) over the MF fields (191.2%). OF enhanced grain elongation, kernel length, kernel breadth and their ratio compared to INM and MF practice. OF enhanced grain amylose content and slickness but reduced crude protein content compared to INM and MF. Organic cultivation exhibited higher amylose content (25.3%) as compared to 21.7 % in conventional fields. Tripathi and Verma (2008) also found same type of results. However, Elaine *et al.* (2007) found no difference in apparent amylose and mineral contents due to organic cultivation. Total nitrogen and crude protein content was considerably higher

under inorganic (1.57% total N, 9.87% crude protein) compared to organic cultivation (1.38% total N and 8.6% crude protein).

Considerable reduction in incidence of key insect pests and diseases due to use of microbial and botanical pesticides were observed. Population of individual natural enemies like spiders, crickets (egg predators), damselflies, ants, bettles, wasps and mermithids were noticed predating on larval stages of insect pests. Comparison of plant protection practices showed that conventional farmers group by and large were not risk evasive and go for spray of chemical pesticides for managing weeds, insects and plant diseases as per recommended schedule or sometimes even before that. However, in organic fields the crop was managed by alternative eco-friendly pest management method, which mainly relied on cultural, microbial and bio-rational approaches. These results are in line with the description of Reganold (2006). Natural enemies play an important role in regulating pests, pest outbreaks often occur in intensive agricultural practice due to imbalance between pests and natural enemies by the use of indiscriminate use of pesticides (Heong and Schoenly, 1998).

Thus, grain yield, profitability and quality of aromatic rice with organic nutrient management was significantly better compared to INM and mineral fertilization. There was improvement in chemical, physical and microbiological quality of soil also in organic farming.

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