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Research Communication

Integrated crop management modules for enhancing productivity and profitability of direct-seeded basmati rice (*Oryza sativa*)

KAJAL DAS[1], VIJAY POONIYA[2], ANIL K. CHOUDHARY[3], K. SWARNALAKSHMI[4], C.M. PARIHAR[5], R.S. BANA[6] AND S.K. SARKAR[7]

ICAR–Indian Agricultural Research Institute, New Delhi 110 012

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ABSTRACT

A field experiment was conducted during rainy season (June–October) of 2016, to study the effect of different integrated crop management (ICM) modules on productivity and profitability of direct-seeded basmati rice. The experiment was laid out in a randomized block design with eight treatment combinations, i.e. ICM modules (ICM_1 to ICM_8). The study indicated that the yield attributes, grain yield (4.03 t/ha), harvest index, as well as gross (₹96,253/ha) and net (₹50,693/ha) returns as well as gross B: C ratio (2.11) of rice crop were significantly higher in the ICM_7, i.e. zero till (ZT)-summer mungbean residue retention (SMB-RR) + ZT- direct seeded rice (DSR) + wheat residue @ 3 t/ha + 75% of recommended dose of fertilizers @ 100 : 50 : 50 kg N : P_2O_5 : K_2O/ha (RDF) (N through Zn coated urea/ZCU) + glyphosate as pre-plant (PP) @ 1 kg a.i./ha + pretilachlor as pre-emergence (PE) @ 0.75 kg a.i./ha followed by bispyribac-sodium @ 25 g a.i./ha as post emergence (POE) at 25 days after sowing (DAS) + need based water management, disease and integrated pest management, with comparison to other modules. The escalation of cost due to transplanting was increased ₹5,045/ha compared to direct–seeded rice. The increase in net returns with ICM_7 was 36.7, 41.4 and 9.3% over ICM_1, conventional transplanting/TPR + 100% of RDF + butachlor-PE @ 1 kg a. i./ha + 1 hand-weeding (HW); ICM_6, ZT-DSR + wheat residue @ 3 t/ha + 75% RDF + AMF + NPK-*biofertilizer* + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a.i./ha followed by bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS + 1 HW and ICM_8, ZT-SMB-RR + ZT- DSR + wheat residue @ 3 t/ha + 50% RDF + AMF + NPK-*bf* + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a.i./ha followed by bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS + 1 HW), respectively. Hence, the superior ICM module, i.e. ICM_7 may be useful for improving profitability and B : C ratio of direct-seeded rice with respect to other modules.

Key words : Direct seeded rice, Integrated crop management, Productivity, Profitability

Rice (*Oryza sativa* L.) is an important staple food of Asian population providing ~35–80% of total calorie intake. Basmati rice is a geographical indication and famous for their desirable cooking quality parameters used to prepare several dishes. The higher water requirement for the conventional rice is alarmingly receding the ground water table in upper and trans Indo-Gangetic Plains Region (IGPR) by ~30–40 cm every year (Mahajan *et al.,* 2012) and inefficient input use and irrational production practices resulting in decline system productivity and resource-use-efficiency. In India, traditional transplanting practices is most common in IGPR and this has several advantages like increased nutrient availability (P and Fe), weed suppression and stop percolation, easy crop establishment on one hand with drawbacks like higher loss of water in puddling, more time and labour requirement, surface evaporation, root injury due to uprooting of seedling and adversely affect soil physical properties through puddling operations and more water requirement on other hand. Pumping excessive water for puddling during peak summer in north-western Indo-Gangetic plains leads to declining water table. Keeping above facts in view, direct-seeded rice (DSR) is a potential alternative and offers advantages like faster and easier planting, reduced labour and less drudgery, earlier crop maturity by 7–10 days, more efficient

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[1]**Corresponding author's Email**: kdas5507@gamil.com
[1]Ph.D. Scholar, [2,5,6]Scientist, [3]Senior Scientist, Division of Agronomy, [4]Senior Scientist, Division of Microbiology, ICAR-Indian Agricultural Research Institute, [7]Scientist, Division of Agricultural Statistics, ICAR-Indian Agricultural Statistics Research Institute, Pusa Campus, New Delhi 110 012

water use and less methane emission with higher profitability (Farooq *et al.,* 2008). It is being followed with various modifications of tillage and crop establishment practices which are used to suit site–specific requirements, but has not got popularity, even though its benefits over traditional transplanting because of deficiency of nutrients (Fe and Mn), weeds and nematodes infestation, which can cause maximum yield losses in direct–seeded rice. Weeds are emerging as the most important problem in DSR due to presence of weed seed banks in the soil, early crop weed competition and lack of standing water for suppressing the weeds. Furthermore, chemical and mechanical weeding, other agronomic interventions may also play important role in better crop management along with weed control. Therefore, it is quite possible that various management strategies in integrated manner under different crop establishment methods including zero tillage (ZT), mulching and residue intervention may influence the weed and nutrient dynamics, enhance productivity and sustainability of rice. In above context, integrated crop management (ICM) practices hold great promises which take into account economical, social and environment sustainability (Kumar and Shivay, 2008). Thus, present study was conducted to find out the effect of different integrated crop management modules for enhancing productivity and profitability of direct-seeded basmati rice.

The experiment was conducted at the experimental farm of ICAR-Indian Agricultural Research Institute (IARI), New Delhi, India, situated at latitude of 28°38' N and longitude of 77°09' E and 228.6 m above the mean sea-level. During the crop growth period, the temperature and RH ranged between 21°C to 39.2°C and 42 to 98%, respectively. Total rainfall received during crop season was 1153.5 mm. The soil of experimental site was sandy-clay-loam in texture with *p*H 7.9, oxidizable-SOC 0.503%, alkaline $KMnO_4$ oxidizable-N 169.5 kg/ha, 0.5 M $NaHCO_3$ extractable-P 11.5 kg/ha, and 1 N NH_4OAc extractable-K 275.3 kg/ha. The experiment was laid out in randomized block design with 8 treatment combinations i.e. ICM modules with 3 replications. ICM modules include ICM_1, conventional transplanting (TPR) + 100% of recommended dose of fertilizers @ 100:50:50 kg N: P_2O_5: K_2O/ha (RDF) + butachlor as pre-emergence (PE) @ 1 kg a. i./ha + 1 hand-weeding (HW); ICM_2, TPR + 75% RDF (N through zinc coated urea/ZCU + NPK bio-fertilizer/NPK-*bf*) + butachlor as PE @ 1 kg a.i./ha + 1 HW; ICM_3, Direct seeded rice (DSR) + 100% of RDF (N through ZCU) + pretilachlor as PE @ 0.75 kg a.i./ha followed by (*fb*) bispyribac-sodium @ 25 g a.i./ha as post-emergence (POE) at 25 DAS; ICM_4, DSR + 75% RDF + AM fungi (AMF) + NPK-*bf* + pretilachlor as PE @ 0.75 kg a. i./ha *fb* bispyribac-sodium @ 25 g a. i./ha as POE at 25 DAS +

Table 1. Effect of integrated crop management modules on yields and profitability of direct-seeded basmati rice

Treatment	Panicles/ m^2	Panicle length (cm)	Panicle weight (g)	Grain weight (g/panicle)	1,000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Cost of cultivation (× 10^3 ₹/ha)	Gross returns (× 10^3 ₹/ha)	Net returns (× 10^3 ₹/ha)	Gross benefit: cost ratio
ICM_1	323.3	28.3	2.41	2.34	25.4	3.68	5.94	38.3	51.1	88.2	37.1	1.73
ICM_2	311.7	28.3	2.50	2.43	25.7	3.36	6.06	36.0	48.3	80.8	32.6	1.68
ICM_3	338.3	26.4	2.12	2.03	25.2	3.02	5.59	35.1	43.0	72.9	29.9	1.70
ICM_4	322.3	27.7	2.22	2.07	25.3	3.16	5.69	35.7	43.4	76.1	32.7	1.75
ICM_5	341.7	25.0	2.04	1.94	25.1	3.26	5.62	36.7	44.3	78.4	34.1	1.77
ICM_6	335.3	26.2	2.03	1.94	25.1	3.38	5.98	36.0	45.5	81.3	35.8	1.79
ICM_7	343.7	26.9	2.08	2.02	25.2	4.03	5.81	41.0	45.6	96.3	50.7	2.11
ICM_8	316.7	26.7	2.11	2.07	25.2	3.87	5.77	40.3	46.2	92.5	46.4	2.01
SEm±	4.72	0.64	0.05	0.04	0.08	0.155	0.374	1.16	–	3.71	3.71	0.08
CD (P=0.05)	14.33	1.96	0.14	0.12	0.23	0.471	NS	3.52	–	11.3	11.3	0.24

ICM, Integrated crop management; ICM_1, Conventional transplanting (TPR) + 100% of recommended dose of fertilizers @ 100 : 50 : 50 kg N : P_2O_5 : K_2O/ha (RDF) + butachlor as pre-emergence (PE) @ 1 kg a.i./ha + 1 hand-weeding (HW); ICM_2, TPR + 75% RDF (N through zinc coated urea/ZCU + NPK bio-fertilizer/NPK-bf) + butachlor as PE @ 1 kg a.i./ha + 1 HW; ICM_3, Direct seeded rice (DSR) + 100% of RDF (N through ZCU) + pretilachlor as PE @ 0.75 kg a.i./ha followed by (fb) bispyribac-sodium @ 25 g a.i./ha as post-emergence (POE) at 25 DAS; ICM_4, DSR + 75% RDF + AM fungi (AMF) + NPK-bf + pretilachlor as PE @ 0.75 kg a.i./ha fb bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS + 1 HW; ICM_5, Zero tillage (ZT)-DSR + wheat residue @ 3 t/ha + 100% of RDF (N through ZCU) + glyphosate as pre-plant application (PP) @ 1 kg a.i./ha + pretilachlor as PE @ 0.75 kg a.i./ha fb bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS; ICM_6, ZT-DSR + wheat residue @ 3 t/ha + 75% RDF + AMF + NPK-bf + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a.i./ha fb bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS + 1 HW; ICM_7, ZT-summer mungbean residue retention (SMB-RR) + ZT- DSR + wheat residue @ 3 t/ha + 75% RDF (N through ZCU) + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a.i./ha fb bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS and ICM_8, ZT-SMB-RR + ZT- DSR + wheat residue @ 3 t/ha + 50% RDF + AMF + NPK-bf + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a.i./ha fb bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS + 1 HW and need based integrated water, disease and pest-management followed in all modules

1 HW; ICM_5, zero tillage (ZT)- DSR + wheat residue @ 3 t/ha + 100% of RDF (N through ZCU) + glyphosate as pre-plant application (PP) @ 1 kg a.i./ha + pretilachlor as PE @ 0.75 kg a.i./ha *fb* bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS; ICM_6, ZT-DSR + wheat residue @ 3 t/ha + 75% RDF + AMF + NPK-*bf* + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a.i./ha *fb* bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS + 1 HW; ICM_7, ZT-summer mungbean residue retention (SMB-RR) + ZT-DSR + wheat residue @ 3 t/ha + 75% RDF (N through ZCU) + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a.i./ha *fb* bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS and ICM_8, ZT-SMB-RR + ZT-DSR + wheat residue @ 3 t/ha + 50% RDF + AMF + NPK-*bf* + glyphosate as PP @ 1 kg a.i./ha + pretilachlor-PE @ 0.75 kg a. i./ha *fb* bispyribac-sodium @ 25 g a.i./ha as POE at 25 DAS + 1 HW and need based water management (IW_rM), integrated disease management (IDM) and integrated pest management (IPM) followed in all modules. The mungbean residue was retained using paraquat spray on standing mungbean crops 4–5 days before sowing of direct-seeded rice. Rice variety 'Pusa Basmati 1509' was sown using a seed rate of 30 kg/ha on 17th June, 2016. All the practices and inputs were followed based on the treatment combinations.

The study revealed that yield attributes i.e. panicles/m^2, panicle length (cm), panicle weight (g), grain weight/panicle, filled grains/panicle, 1,000–grain weight (g) and grain yield (t/ha) were significantly differed among the treatments or ICM modules; while straw yield (t/ha) was found non–significant (Table 1). The yield attributing parameters maximum with ICM_7 a CA based ICM module which remained at par with ICM_5, and ICM_6. The CA based ICM modules ICM_7 under wheat and summer mungbean residue retained plot exhibited higher magnitude of yield attributing characters over conventional tillage (CT) based ICM modules which might be the outcome of better crop growth performance under zero-tilled based ICM modules owing to improved soil physico–chemical and biological properties due to less farm machinery trafficking (Paul *et al*., 2014), more soil organic matter and nutrient additions by the crop residue retentions (Paul *et al.*, 2014; Prasad *et al.*, 2016), and the degradation of weed flora by the pre–plant application of non–selective herbicide, i.e. glyphosate @ 1.0 kg a.i./ha under zero-tilled plots. The ZT with residue retention based ICM modules are also reported to holds more moisture in soil (0–15 cm depth) over CT plots (Paul *et al*., 2014) coupled with less weed incidence over CT based ICM modules, thus, leading to better crop growth, yield attributes and yield in rice. Also may be due to better availability of macro and micro nutrients, better soil physical and biological properties which ultimately provide balanced nutrition to the crop plants (Dass *et al*., 2014). The cost involved in the cultivation between ₹43,002–51,126/ha among different ICM modules due to varying inputs and agronomic operations like tillage and crop residues, land configuration, fertilizer doses, weed management, water management, pest and disease management etc. (Table 1). The cost of cultivation under CT based ICM modules were comparatively higher due to nursery management, tillage and puddling. The gross returns of rice followed the similar trend as that of grain yield of rice. Net returns and of B: C ratio in rice crop also followed the similar trend as that of gross returns. The escalation of cost due to transplanting was increased ~ ₹5,045/ha compared to direct–seeded rice. The increase in net returns with ICM_7 was 36.7, 41.4 and 9.3% over ICM_1, ICM_6 and ICM_8.

Direct-seeded basmati rice under CA based integrated crop management practices is an option to increase productivity and profitability over other ICM modules. Overall, conservation agriculture based ICM_7 module was the best performer and it may be useful to farmers for improving profitability and sustainability in the Indo-Gangetic plains of North-western India.

REFERENCES

Dass, A., Shekhawat, K., Choudhary, A.K., Sepat, S., Rathore, S.S., Mahajan, G. and Chauhan, B.S. 2016. Weed management in rice using crop-competition–A review. *Crop Protection,* DOI: doi.org/10.1016/j.cropro.2016.08.005.

Farooq, M., Basra, S.M.A. and Asad, S.A. 2008. Comparison of conventional puddling and dry tillage in rice–wheat system. *Paddy and Water Environment* **6**(4): 397–404.

Kumar, D. and Shivay, Y.S. 2008. Integrated crop management. National Science Digital Library, NISCAIR, New Delhi, *http://nsdl.niscair.res.in/jspui/handle/123456789/679*.

Mahajan, G., Singh, K. and Gill, M.S. 2012. Scope for enhancing and sustaining rice productivity in Punjab (food bowl of India). *African Journal of Agricultural Research* **7**(42): 5611–5620.

Paul, J., Choudhary, A.K., Suri, V.K., Sharma, A.K., Kumar, V. and Shobhna. 2014. Bio-resource nutrient recycling and its relationship with bio-fertility indicators of soil health and nutrient dynamics in rice–wheat cropping system. *Communications in Soil Science and Plant Analysis* **45**(7): 912–924.

Prasad, D., Rana, D.S., Babu, S., Choudhary, A.K. and Rajpoot, S. 2016. Influence of tillage practices and crop diversification on productivity and soil health in maize (*Zea mays* L.)-soybean (*Glycine max* L.) based cropping systems. *Indian Journal of Agricultural Sciences* **86**(1): 96–102.