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Research Communication

Sustaining Indian mustard (*Brassica juncea*) productivity and soil health through varietal diversification under diverse production systems

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ABSTRACT

Indian mustard is one of the most important oilseed crop in India as it contributes maximally in domestic edible oil production. Inclusion of Indian mustard in cereal based cropping system is increasingly felt due to its beneficial effect in the system and comparatively lesser requirement of resources, hence lesser environmental footprints. To assess the feasibility of different cultures for profitable diversification, as field experiment was conducted during *rabi* 2020–21 at the research farm of IARI, New Delhi. The varietal diversification in Indian mustard has further helped in bringing the resilience in the production system. The study revealed that Pusa mustard 26 under integrated crop management system resulted in higher seed yield (2,206, kg/ha), biological yield (10,711 kg/ha), oil yield (877.0 kg/ha) and also enhanced net return (₹76,060/ha).

***Key words*:** Varietal diversification, integrated crop management, Gross return, Harvest index, Net return, Seed yield

The increasing biotic and abiotic stresses in crop production are causing many problems alike escalating cost of production, decreasing response to applied inputs, and factor productivity. The chemical-based management for managing biotic stresses also leading to environmental problems and many more indirect negative effects. Hence the alternative methods of managing these stresses in crop production are urgently warranted. In this regard, the crop diversification is one of the potential practices which can minimize the effect of different types of biotic and abiotic stresses (Rathore *et al.,* 2019a, Baishya *et al.,* 2019). Indian mustard is the largest contributor of domestic oil production in India, still huge gap exists in present and potential productivity (Rathore *et al.,* 2014). Generally, crop diversification perceived a change from the regional supremacy of one crop to regional production of many of crops, to meet ever-increasing demand of cereals, pulses, vegetables, fruits, oilseeds, fibers, fodder, grasses etc of the population. Crop diversification also guarantees higher profits of the growers. It also aims to improve soil health and to maintain dynamic equilibrium of the agro-ecosystem. Further, in India crop diversification is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops (Rathore *et al.,* 2019b). Despite being the third largest producer (11.3%) of oilseed brassica after Canada and China in the world, India meets 57% of the domestic edible oil requirements through imports. Despite of signicant progress achieved in the oilseeds production in India, vegetable oils import is 11.2% of the total world import worth of about ₹1.0 lakh crore during 2020–21. Oilseed brassica achieved signicant growth in India in the past, however, the productivity levels are still low owing to large cultivation under rainfed situation, biotic and abiotic stresses, and resources crunch. Almost 72% of the total oilseeds area is confined to rainfed farming cultivated mostly by marginal and small farmers. Lack of appropriate technologies, cultivation under input-starved conditions, combating the biotic and abiotic stresses are some of the major causes for poor productivity of Oilseeds.

The experiment was conducted during the winter season of 2020–21 at the Research Farm of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi, (28.63° N, 77.15° E, 228.6 m above mean sea level) The field has an even topography and good drainage system. Soil of the experimental field belongs to Inceptisols, having sandy loam texture in top 30 cm layer. Composite

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soil sampling was accomplished from 0 to 15 cm depth randomly before sowing of the crop from different spots of the field by using core sampler. The samples were shade-dried, grounded and sieved through a 2-mm sieve for further physical and chemical properties analysis. The samples were analyzed for major plant nutrients. The field experiment was laid out in a split-plot design in fixed layout with 3 replications. The experiment comprised 4 main plot treatments (production systems: organic management system, integrated crop management, conventional system and conservation agriculture system) and 3 sub plot treatments Var: 'PM 26', 'PM 28' and 'PDZ 1'). Sowing was done on 22 October 2020 after application of 60 mm pre-sowing irrigation. The crop was harvested on 6 March 2021. Observations were recorded on productivity, economics and soil health.

There was almost 14% increase in seed yield under Integrated Crop Management compared to Conventional System, but lower seed yield was recorded under Organic Management System than Conventional System (Fig. 1). However, under Conservation Agriculture, significantly higher seed yield was recorded than it was under Conventional System. Among the Indian mustard varieties, 'PM 26' gave the maximum seed yield (2,206 kg/ha), closely followed by 'PM 28' (2,123 kg/ha), while the least seed yield was recorded under 'PDZ 1'. All the varieties gave higher seed yield under ICM except 'PDZ 1' (1,810 kg/ha), which yielded the maximum seed output under CA. Under OMS and ICM, higher harvest index (0.23 and 0.24, respectively, was observed which was higher than HI under CS and CA. Among the Indian mustard varieties, 'PM 28' variety recorded significantly higher HI (0.24) compared to 'PM 26' and 'PDZ 1'. However, under CA, higher seed yield was obtained than in CS. It was mainly owing to better soil health, moisture retention, thermal regulation and nutrient release (Shekhawat *et al.*, 2012; Shekhawat *et al.,* 2016 and Rathore *et al.*, 2019a). If sufficient quantity of organic manures is added along with mineral fertilizers, perhaps there would be no need of adding micronutrients. This may be another reason for assured supply of all essential nutrients in the soil.

The cost of cultivation for operational cost on per ha basis varied from ₹21,499 to ₹28,468/ha, the ICM incurred the maximum cost of ₹28,468/ha, followed by OMS (Table 1). The least cost was recorded under CA (₹21,499/ha). In all the varieties, similar cost of cultivation of ₹26,521/ha was recorded. The gross returns were maximum under ICM (₹105,051/ha), while the least under OMS (₹89,914/ha), which was lesser than gross return under conventional system (₹92,337/ha). The gross return from Indian mustard under CA (ZTRR) was higher than CS and OMS. The gross return from 'PM 26', 'PM 28' and 'PDZ 1' was 10,2581, 98,735 and 84,186 /ha respectively. The trend in net returns was also same, as it was in gross return. The maximum net return was obtained under ICM (₹76,583/ha) and among the varieties, 'PM 26' gave maximum net return of ₹76,060/ha. The CA and CS resulted in higher benefit: cost ratio (3.3 and 3.12 respectively) compared to OMS and ICM, while among the varieties maximum benefit: cost ratio was from 'PM 26' (3.22) and the least from 'PDZ 1' (2.51). The profitability was noticed from 412–638 /ha/day, the maximum was under ICM (638/ha/day) and among the

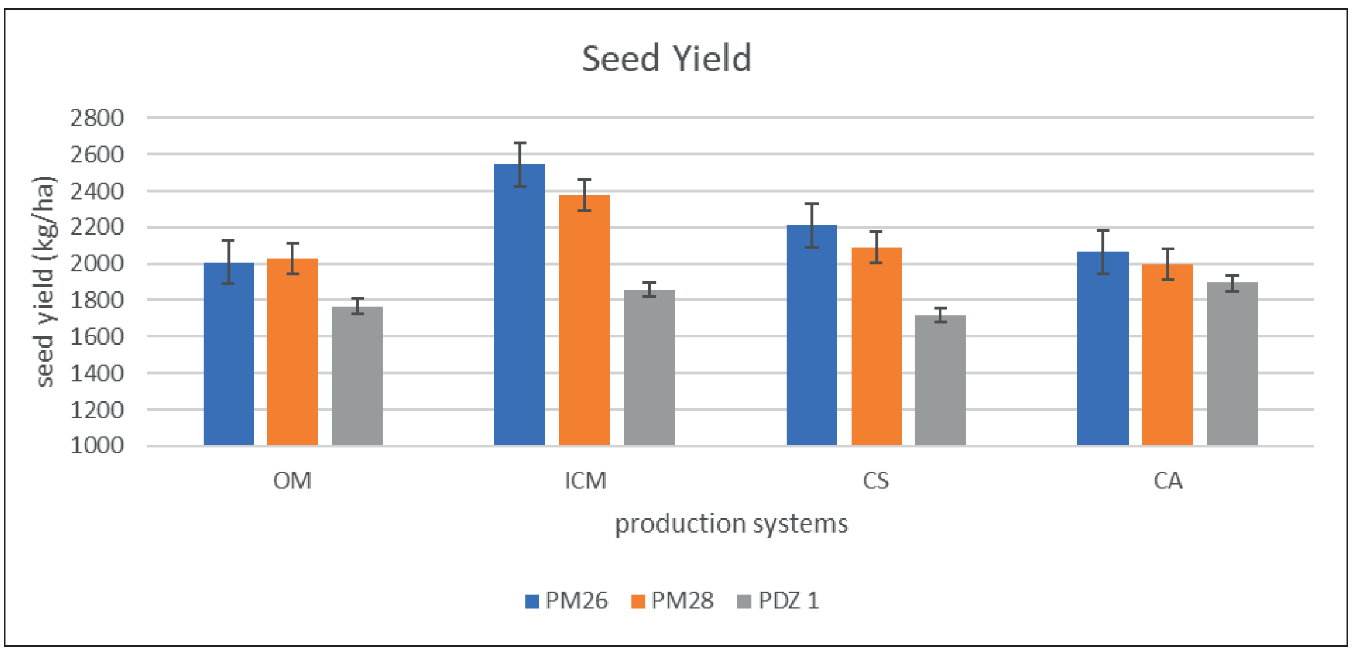

Fig 1. Seed yield of different Indian mustard varieties under diverse production systems.
Note: Soil health results and discussion is

varieties 'PM 26' exhibited higher profitability (634/ha/day). Nitrogen content in stover varied from 0.46 to 0.52%, the maximum Nitrogen content in Indian mustard stover and seed was under ICM (0.52 and 3.02% respectively).

Among the varieties, Nitrogen content remained at par (0.5 to 0.51% in stover), while significantly higher N% content was estimated in 'PM 26' and 'PM 28' over 'PDZ (Table 1). The N uptake was significantly influenced by diverse production systems in different varieties. The N uptake in stover, seed and total uptake was higher under ICM (38.24, 68.72 and 106.9 kg/ha respectively), while in case of different varieties, 'PM 26' showed higher uptake of N in stover, seed and also total N (43.18, 62.87 and 106.06 kg/ha respectively). Among the varieties, the N, P and K content and uptake were higher under ICM production system. Soil organic carbon varied from 0.55 to 0.68% at initial stage of field experimentation in different production systems.

Therefore, it can be concluded that 'PM 26' and 'PM 28' resulted in better yield and nutrient uptake (Shekhawat *et al.,* 2012). Organic manure integration including the vermi-composting also improve a soil Shekhawat *et al.,* 2012 are yield & quality as also recorded by Premi *et al.,* 2012). Integrated use of organic and inorganic fertilizers not only ensures availability of all the essential plant nutrients but also improves the crop productivity (Meena *et al.,* 2015; Yadav and Kumar 2018).

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Table 1. Effect of varietal diversification on yields economics, N uptake under diverse production systems of Indian mustard

Production Systems	Seed yield kg/ha	Biological yield kg/ha	Oil yield kg/ha	Net return ₹/ha	Benefit: cost ratio	SOC %	N content %		N uptake kg/ha	
							Stover	Seed	Stover	Seed
OMS	1,934	8,840	761	62,496	2.61	0.68	0.51	2.85	36.73	55.23
ICM	2,259	9,244	908	76,583	2.70	0.66	0.52	3.02	38.24	68.72
CS	1,986	8,928	777	68,768	3.12	0.51	0.48	2.75	29.83	51.75
CA	2,008	9,936	774	70,838	3.30	0.62	0.52	2.84	41.93	56.38
SEm±	72.3	478.8	30.4	3,362	0.12	0.003	0.01	0.05	1.99	2.80
CD (P=0.05)	250.2	1,656.8	105.3	11,633	0.43	0.013	0.03	0.19	6.88	9.70
Varieties										
'PM 26'	2,206	10,711	877	76,060	3.22	0.66	0.51	2.83	43.18	62.87
'PM 28'	2,123	8,659	834	72,214	3.07	0.67	0.51	2.84	33.60	60.60
'PDZ1'	1,810	8,341	704	57,664	2.51	0.70	0.50	2.78	33.28	50.59
SEm±	40.7	3,34.9	16.3	1,894	0.07	0.004	0.01	0.02	1.644	1.32
CD (P=0.05)	122.1	1,003.9	48.9	56,770	0.21	NS	NS	NS	4.93	3.96