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Effect of organic manure and *neemastra* on growth and yield of Indian mustard varieties in lower gangetic plains of West Bengal

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ABSTRACT

A field experiment was conducted in split split-plot design replicated thrice during rabi season of 2017-2018 to study the effect of organic manure and neemastra on growth and yield of Indian mustard varieties. The application of bulky organic manures [FYM @ 6 t ha^{-1} (N_2), Vermicompost @ 2 t ha^{-1} (N_3), and FYM @ 3 t ha^{-1} + Vermicompost @ 1 t ha^{-1}(N_4)] with foliar spray of Panchagavya recorded significantly higher growth attributes viz. plant height, dry matter yield and CGR over liquid manure only (3% Panchagavya) [N_1]. Based on seed yield, the nutritional treatments could be arranged as: N_2 (11.19 q ha^{-1}) > N_4 (10.62 q ha^{-1}) > N_3 (9.92 q ha^{-1}) > N_1 (8.90 q ha^{-1}). Sarama produced higher seed yield (10.57 q ha^{-1}) due to significant improvement in number of siliquae plant^{-1} (116.9) and number of seeds siliqua^{-1} (13.8) compared to Bhagirathi (9.79 q ha^{-1}). The combined application of FYM and Panchagavya led to the highest oil content (35.3%) and net income (₹ 19,676 ha^{-1}) compared to other nutritional treatments. Neemastra as botanical insecticide was found effective to control aphid upto 1 week after respective three foliar sprays at 3, 6 and 9 WAS, in the study.

***Keywords*:** Economics, growth, Indian mustard, *neemastra*, organic manure, yield

A large number of species and sub-species of oilseeds are cultivated in India under the name rapeseed and mustard, of which Indian mustard (*Brassica juncea* L. Czern.), commonly known as *rai*, *raya* or *laha*, is one of the most important *rabi* oilseed crop of Rajasthan, Gujarat, Madhya Pradesh, Uttarakhand, Uttar Pradesh, Bihar, West Bengal and Assam.

Although it is a major oilseed crop, but its productivity in the country as well as in West Bengal is much low, which continues to be worrying issue for agricultural investigators or researchers. Apart from improved varieties and judicious irrigation, use of balanced chemical fertilizers is critical for realizing higher yield. On the other hand, continuous deterioration of soil health is also a challenging issue in the present era. Under such situation organic manures can be exploited to boost the soil health condition vis-a-vis production of crops and to improve fertilizer use efficiency (Tripathi *et al*., 2011). The mustard aphid is a serious pest of mustard in India and other tropical regions in the world (Sahoo and Saha, 2018) and farmers generally apply different chemicals and even sometimes banned chemicals at repeated frequency in high dose, that lead several problems *viz.* environmental pollution, development of aphid resistance to insecticides, harmful effects on non-target organisms including pollinators, aphid resurgence, upsetting the balance of nature and threat to the human health. Realization of negative consequences of chemical pesticides on nature as well as on human health, botanical pesticides may be included as the best viable and sustainable options other than chemical method of pest control (NARC, 1992). So, identification of suitable organic manures and botanical pesticides with their application schedule in Indian mustard is need of hour to get increasing demand of pesticide residue free good quality mustard oil as well as to sustain soil health.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2017-18 at 'C' Block Farm (22.5^0 N, 89.0^0 E and 9.75 m altitude) of Bidhan Chandra Krishi Viswavidyalaya (B.C.K.V.), Kalyani, Nadia, West Bengal, India, in Gangetic alluvial (order Inceptisol) of sandy-loam class soil. The experiment was laid out in split-split plot design, where four organic nutrient management (N_1: 3% *Panchagavya* at 30 and 50 DAS; N_2: FYM @ 6 t ha^{-1} as basal + N_1; N_3: Vermicompost @ 2 t ha^{-1} + N_1 and N_4: FYM @ 3 t ha^{-1} + Vermicompost @ 1 t ha^{-1} + N_1) were allotted in main plots, two organic pest management (P_1: Control and P_2: 5% *neemastra* at 21, 42 and 63 DAS) in sub plots, and two variety (V_1: Bhagirathi and V_2: Sarama) in sub-sub plots.

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The seeds @ 5 kg ha^{-1}, mixed with moist loose soil, were dropped continuously in furrows manually (1.5-2 cm deep) at 30 cm apart opened with the help of tyne. Thinning was done at 16 DAS to remove excess seedlings having poor growth for maintenance of optimum plant population. Two hand weedings were done at 20 DAS and 40 DAS to keep the field under weed-free condition. Two irrigations were given at 55 and 78 DAS due to long dry spell during flowering to maturity stage. *Panchagavya* and *neemastra* were prepared at the farm following standard methods (Ghosh, 2019) before their applications to the crop. The data collected in this experiment were subjected to statistical analysis by the analysis of variance (ANOVA) method suitable for split split-plot design in the investigation (Gomez and Gomez, 1984) using online OPSTAT software.

RESULTS AND DISCUSSION

Plant height, dry matter (DM) production and leaf area index (LAI) of mustard were increased progressively upto 75 DAS irrespective of organic manure, *neemastra* and variety tested in the investigation (Table 1). All three bulky organic manure treated plots (N_2, N_3 and N_4) with foliar spray of *Panchagavya* recorded significantly higher growth attributes (plant height, DM yield and CGR) over the plots treated with only liquid manure (N_1) at different stages. The final plant height was found to vary between 106.3 cm (N_1) and 120.9 cm (N_2) at maturity, maximum LAI between 2.51 (N_1) and 3.05 (N_2) at 50 DAS, and DM production between 208.9 cm (N_1) and 275.4 g m^{-2} (N_2) at 75 DAS. Sarama (V_2) had greater plant height (116.5 cm) at harvest, LAI (3.37) at 50 DAS, DM yield (259.7 g m^{-2}) at 75 DAS than Bhagirathi (V_1) in the experiment.

The yield components of two Indian mustard varieties (*i.e.,* number of branches plant^{-1}, number of siliquae plant^{-1} and number of seeds siliqua^{-1}) excluding test weight were varied significantly among four nutritional treatments in the study (Table 1). Based on seed yield, four nutritional treatments for *rai* could be arranged as: N_2 (11.19 q ha^{-1}) > N_4 (10.62 q ha^{-1}) > N_3 (9.92 q ha^{-1}) > N_1 (8.90 q ha^{-1}), which indicated 20.5, 16.9 and 10.3% greater yield over N_1 (Table 2). Murali *et al*. (2018) got higher seed yield of Indian mustard (1.25 to 1.49 t ha^{-1}) under different organic nutrient managements over non-treated control during *rabi* season at Allahabad. The plant extract (*neemastra*) sprayed thrice in the study recorded higher seed yield (10.27 q ha^{-1}) over control (10.09 q ha^{-1}), which could be explained by its efficacy to reduce the incidence of aphid in mustard field thereby facilitating better development of yield associated characters. Sarama (V_2) yielded highest (10.57 q ha^{-1}) due to significant improvement in number of siliquae plant^{-1} and number of seeds siliqua^{-1}, and that yield was 0.78 q ha^{-1} higher over Bhagirathi (V_1). The application of FYM @ 6 t ha^{-1}as basal along with two foliar spray of 3% *Panchagavya* at 30 and 50 DAS resulted in greater oil content (35.3%) compared to other nutritional treatments adopted in the study. Sarama (V_2) had higher oil content (34.7%) than Bhagirathi (32.6%) in the investigation. Kumawat *et al*. (2014) suggested the application of FYM @ 20 t ha^{-1} along with 80 kg N + 40 kg P_2O_5 ha^{-1} for Indian mustard to get maximum plant height, DM accumulation, number of branches plant^{-1}, siliquae plant^{-1}, seeds siliqua^{-1}, 1000 seed weight, seed and stover yields over 10 t FYM ha^{-1} with same dose of inorganic fertilizer at Bikaner, Rajasthan.

The common cost of cultivation included cost of seed, land preparation, sowing of seeds, thinning and weeding, irrigation, harvesting, threshing, etc., excluding organic manures, liquid manure and botanical pesticide used in the study. The common cost was ₹ 16300 but the total cost varied due to different treatments including organic manures, liquid manure and botanical pesticide used in the study. Two labours were required to spray 1 hectare area. Total cost of cultivation of mustard was found to vary between ₹ 20,225 ha^{-1} (N_1) and ₹ 31,325 ha^{-1} (N_3) (Table 2), while, gross return included the values of seeds and stover as obtained from different treatment combination, which varied between ₹ 37,375 (N_1) and ₹ 47,001 ha^{-1} (N_2) at Kalyani, Nadia, West Bengal. The maximum net income (₹ 19,676 ha^{-1}) was obtained from N_2 (FYM @ 6 t ha^{-1} + 3% *Panchagavya* at 30 and 50 DAS), while the lowest net return (₹ 10,351 ha^{-1}) was noted with N_3 (Vermicompost @ 2 t ha^{-1} + 3% *Panchagavya* at 30 and 50 DAS). Similar finding was reported by Tripathi *et al*. (2010), where integrated nutrient management in Indian mustard with FYM fetched higher net return (₹ 19,505 ha^{-1}) at Panthnagar, Uttarakhand. The plots treated with two foliar spray of 3% *Panchagavya* only (N_1) recorded the highest benefit-cost ratio (1.85) compared to other three organic nutrient practices involving higher costs for respective organic manures.

The susceptibility of mustard to aphid (*Lipaphis erysimi*) was increased progressively with the advancement of crop growth or age, and severe infestation was found at maturity (Fig. 1). The three spray schedules of *neemastra* at 3, 6 and 9 WAS had significant protective effects against aphid infestation in mustard plants of the treated plots (P_2) compared to the unprotected check (P_1) (Fig. 1). A careful study on aphid infestation data for a period from 3 to 11 WAS revealed that the effectiveness of *neemastra* was evident upto 1 week after their respective foliar applications, beyond which its effect could not be persistent in the

Table 1 : Effect of organic manure, *neemastra* and variety on growth attributes of Indian mustard

Treatment	Plant height (cm) at harvest	LAI at 50 DAS	DM accumulation (g m^{-2}) at 75 DAS	CGR (g m^{-2} day^{-1}) at 50–75 DAS	Branches $plant^{-1}$	Siliqua $plant^{-1}$	Seeds $siliqua^{-1}$	1000 seed weight (g)
Organic manure								
N_1, 3% *Panchagavya* at 30 and 50 DAS	106.3	2.51	208.9	4.05	4.1	101.8	12.3	2.52
N_2, FYM @ 6 t ha^{-1} as basal + N_1	120.9	3.05	275.4	4.92	5.3	116.1	14.0	2.65
N_3, Vermicompost @ 2 t ha^{-1} + N_1	112.6	2.65	264.3	5.19	5.3	117.1	13.2	2.67
N_4, FYM @ 3 t ha^{-1} + Vermicompost @ 1 t ha^{-1} + N_1	117.8	2.99	269.3	5.45	5.0	115.9	13.5	2.63
SEm(±)	**2.72**	**0.04**	**3.62**	**0.23**	**0.25**	**0.24**	**0.27**	**0.05**
LSD (0.05)	**9.38**	**0.13**	**12.51**	**0.78**	**0.87**	**0.84**	**0.93**	**NS**
Neemastra								
P_1, Control	112.1	2.79	247.2	4.68	4.8	112.0	13.1	2.57
P_2, 5% *Neemastra* at 21, 42 and 63 DAS	116.7	2.81	261.8	5.13	5.0	113.5	13.4	2.66
SEm(±)	**1.50**	**0.03**	**4.39**	**0.21**	**0.12**	**0.29**	**0.20**	**0.02**
LSD (0.05)	**NS**	**NS**	**14.30**	**NS**	**NS**	**0.95**	**NS**	**0.06**
Variety								
V_1, Bhagirathi	112.3	2.22	249.3	5.70	4.6	108.5	12.7	2.67
V_2, Sarama	116.5	3.37	259.7	4.11	5.3	116.9	13.8	2.56
SEm(±)	**0.91**	**0.02**	**2.47**	**0.11**	**0.12**	**0.28**	**0.21**	**0.03**
LSD (0.05)	**2.74**	**0.05**	**7.40**	**0.33**	**0.36**	**0.84**	**0.62**	**0.08**

DAS=Days after sowing

Table 2: Effect of organic manure, *neemastra* and variety on yield attributing characteristics, yield and oil content of Indian mustard

Treatment	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Oil (%)	Economics			B:C ratio
				Total cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net income (₹ ha^{-1})	
Organic manure							
N_1, 3% *Panchagavya* at 30 and 50 DAS	8.90	17.67	32.1	20225	37375	17150	1.85
N_2, FYM @ 6 t ha^{-1} as basal + N_1	11.19	23.08	35.3	27325	47001	19676	1.72
N_3, Vermicompost @ 2 t ha^{-1} + N_1	9.92	19.41	33.7	31325	41676	10351	1.33
N_4, FYM @ 3 t ha^{-1} + Vermicompost @ 1 t ha^{-1} + N_1	10.62	21.72	33.7	29325	44618	15293	1.52
SEm(±)	**0.05**	**0.78**	**0.52**				
LSD (0.05)	**0.19**	**2.70**	**1.79**				
Neemastra							
P_1, Control	10.09	19.93	34.1	26225	42382	16157	1.65
P_2, 5% *Neemastra* at 21, 42 and 63 DAS	10.23	21.02	33.3	27875	42954	15079	1.57
SEm(±)	**0.03**	**0.32**	**0.29**				
LSD (0.05)	**0.11**	**1.04**	**NS**				
Variety							
V_1, Bhagirathi	9.75	19.78	32.6	27050	40957	13907	1.54
V_2, Sarama	10.57	21.17	34.7	27050	44379	17329	1.67
SEm(±)	**0.03**	**0.34**	**0.28**				
LSD (0.05)	**0.09**	**1.02**	**0.84**				

Cost of seed = ¹ 41 kg^{-1}, Cost of stalk= ¹ 0.5 kg^{-1}

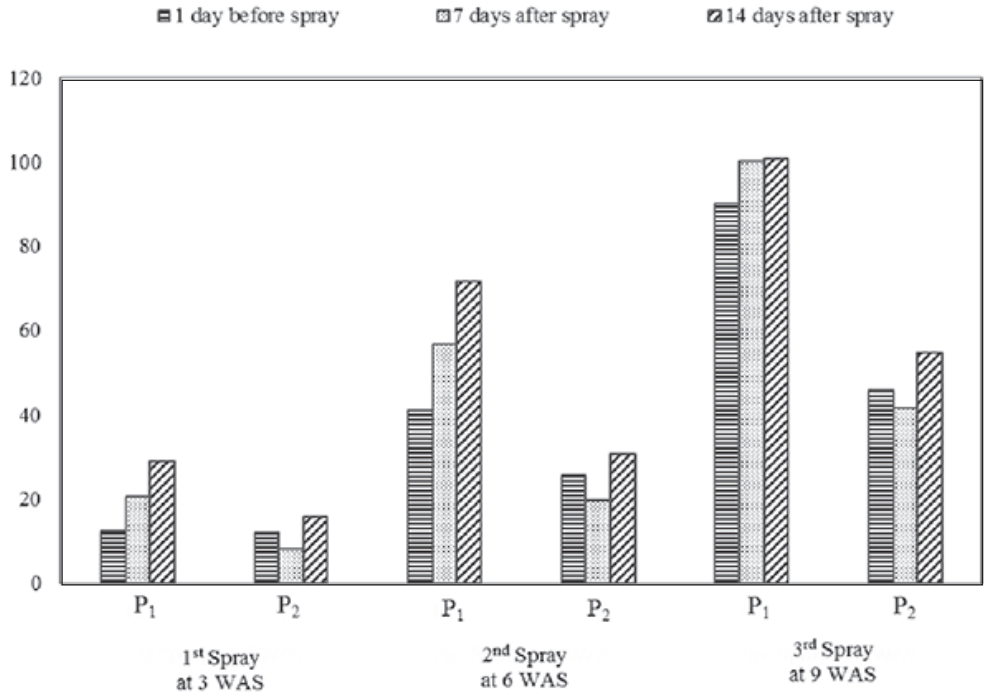

Fig. 1: Effect of *neemastra* on aphid infestation in Indian mustard plots

plant system resulting in increased aphid population. Similar observation on mustard aphid after foliar spray of *Azadirechta indica* leaf extract was reported by Mandal (2019) in Uttar Dinajpur, West Bengal.

Thus, it could be concluded that the application of FYM @ 6t ha^{-1} + foliar spray of 3% *Panchagavya* to Indian mustard varieties resulted in better growth, higher seed yield (11.19 q ha^{-1}), oil content (35.3%) and net income (₹ 19676 ha^{-1}). Sarama performed better in term of seed yield (10.57q ha^{-1}), oil content (34.7%) and net return (₹ 17329 ha^{-1}) than Bhagirathi in the study.

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