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Interactive effect of sowing dates and nutrient sources on dry matter accumulation of Indian mustard (*Brassica juncea* L.)

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Abstract

A field study was conducted during 2015 and 2016 to evaluate the response of the nutrient sources and sowing dates on dry matter accumulation pattern of the Indian mustard (*Brassica juncea* L.). The treatments consisted three sowing dates (November 17, November 27 and December 7) and eight nutrient sources (Control, 100% RDF, 100% RDF + *Azotobactor*, 100% RDF + PSB, 100% RDF + *Azotobactor* + PSB, 75% RDF + 25 % N through Pressmud+ *Azotobactor*, 75% RDF + 25 % N through PM + PSB, 75% RDF + 25 % N through PM + *Azotobactor* + PSB). Results revealed that interaction effect of sowing dates and nutrient sources was observed significant on dry matter accumulation. The application 75% RDF and 25% N through pressmud + *Azotobactor* + PSB on November 17 highest dry matter was recorded at 45 DAS (14.1, 13.4 and 13.8 g plant^{-1}), 90 DAS (49.2, 45.3 and 47.3 g plant^{-1}) and at harvest (53.9, 48.9 and 51.4 g plant^{-1}), during both the years and in pooled analysis, respectively. Moreover, higher dry matter accumulation was observed at the time of harvesting (59.7, 62.5, 61.1 per cent) on 17 November sowing with the application of 75% RDF and 25% N through pressmud + *Azotobactor* + PSB over control of all three sowing dates during both the years, respectively. The present study highlighted the practical importance of the sowing dates and nutrient sources combination effect on dry matter accumulation of Indian mustard.

***Key words**: Azotobacter, dry matter accumulation, Indian mustard, pressmud, sowing dates*

Introduction

India is the third largest country in edible oil economy after USA and China. Oilseed crops, such as soybean, mustard, groundnut and sunflower are the major source of edible oils (Uikey, 2017). In India, total oilseeds production is 320.83 lakh tons, and the contribution of rapeseed-mustard is 79.77 lakh tons that ranks IInd after soybean (137.94 lakh tons) in the India's oilseed economy. Indian mustard (*Brassica juncea* L.) is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, Gujarat, West Bengal, Assam, Bihar and Punjab (DES, 2017). Indian mustard is a temperate as well as tropical climate crop suited a dry and cool weather conditions to attain satisfactory growth parameters. Dry matter is the important parameter for achieving better growth and yield in the crop which mostly influences by the adopting changing management *viz.*, sowing dates and soil fertility management practices under changing the climate (Singh *et al*., 2014). Indian mustard is highly sensitive to climate change and soil fertility (Mandal and Sinha, 2004). Sowing time is a non-monetary input for optimizing the maximum dry matter accumulation and to provide most congenial conditions for maximum light interception and the best utilization of moisture and nutrients to the better plant growth and seed yield (Pattam, 2017, Singh *et al.*, 2011, Meena and Yadav, 2015).

The human induced degradation of natural resources, including soils, represents a major concern for sustainability and is imposing the adoption of organic inputs with chemical fertilizers to mitigate the harmful effects and to sustain the soil health for better crop growth (Banjara *et al*., 2017). Since the industrial era (1880), the amount of greenhouse gases *viz*; CO_2, nitrous oxide (N_2O), and methane (CH_4) significantly increases in the atmosphere (IPCC, 2001), which rises the average surface temperature of Earth (IPCC, 2001). However, the increased temperature deteriorates the soil fertility by faster decomposition of organic matter from the soil and nutrient losses (Kumar and Meena, 2016). While, for this number of emission sources are responsible among them one of the factor is undecomposed pressmud, a byproduct of sugar industry (Lehmann, 2007). Carbon sequestration is the transferring of CO_2 into pools of C that can be stored for long periods of time (Lehmann, 2007; Lal, 2004).

Application of pressmud in terms of organic C and nutrients shows 150% increase in organic carbon after first application and help to maintain soil fertility and help in reducing the impact of global warming as releasing toxic gases in environment (Padalkar and Raut, 2016). Likewise, pressmud as organic manure enhances mustard growth in changing climatic scenario and is critical for realizing higher dry matter production (Tripathi *et al*., 2011, Meena *et al*., 2016). Due to intensive cultivation and use of imbalanced high analysis fertilizers most of the Indian soils are deficient in N, P, and K along with S. Under such situation organic manures can be exploited to boost the soil health condition with the production of crops and to improve fertilizer use efficiency. A balanced combination of pressmud, biofertilizers and chemical fertilizers facilitate profitable and sustainable production (Kumar *et al*., 2017). Today's intensive crop cultivation not only requires the optimum use of chemical fertilizers with organic manures but also requires high fertilizer use efficiency to reduce the fertilizer losses, which can be achieved by inclusion of bio-fertilizers. *Azotobacter* and phosphorus solubilizing bacteria can help in reducing the requirement of chemical fertilizers (Meena *et al*., 2017). They are cheaper, pollution free and renewable (Gudadhe *et al*., 2005). Hence, the objective of the present study was to elucidate the physiological basis of dry matter accumulation variations in Indian mustard through accommodate on sowing dates and balanced nutrition through inclusion of organic source, chemical fertilizers and bio-inoculants.

Materials and Methods

A field experiment was conducted during winter seasons of 2015 and 2016 at the Agricultural Research Farm, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. The soil of the experimental field was sandy clay loam having pH 7.85, 7.62, organic carbon 0.42%, 0.45%, available nitrogen 205.7, 210.3 kg N ha^{-1}, available phosphorus 19.4, 21.1 kg ha^{-1}, available potassium 210.2, 219.9 kg ha^{-1} and available sulphur 20.8, 22.6 mg kg^{-1} during both the years, respectively. The experiment consisted of 24 treatments combinations *viz*., Main plot treatment–three sowing dates(November 17, November 27, December 7) and Sub-plots treatment–eight levels of nutrient sources(Control, 100% RDF, 100% RDF + *Azotobacter*, 100% RDF + PSB, 100% RDF + *Azotobacter* + PSB, 75% RDF + 25 % N through Pressmud+ *Azotobacter*, 75% RDF + 25 % N through PM + PSB, 75% RDF + 25 % N through PM + *Azotobacter* + PSB).Furrows were opened in each plot at a distance of 45×15 cm for the sowing of mustard variety 'Ashirwad' with seed rate of 5 kg ha^{-1}. The half of N and full doses of P and K were applied in furrows after mixing with moist soil. The sources of NPKS were applied through urea, DAP, MOP and elemental sulphur, respectively. The rest half of the nitrogen was top-dressed through urea at early vegetative stage after 40 days. Pressmud compost was applied before15 days of sowing by mixing in soil manually. Biofertilizers applied as seed treatment before sowing with routine procedure. All the agronomic operations were kept uniform in all the plots. Pendimethalin 30 EC @ 1 kg ha^{-1} was applied as pre-emergence spray. Observations on the dry matter accumulation were recorded as per the established norms. The maturity days of crop was observed in first (114, 117), second (110, 114), and third (105, 112) sowing during both the years, respectively. The data were analyzed as per the standard procedure for "Analysis of Variance" (ANOVA) (Gomez and Gomez, 1976).

Results and Discussion

Interaction effects of sowing dates and nutrient sources

An examination of data in table 1 & 3 indicated that the interaction effect of sowing date and nutrient sources were significantly observed on dry matter accumulation of Indian mustard during both the years and in pooled analysis. Results indicated that on 17 November sowing was produce maximum dry matter at 45 days after sowing (14.1, 13.4 and 13.8 g plant^{-1}), 90 DAS (49.2, 45.3 and 47.3 g plant^{-1}) and at harvest stage (53.9, 48.9 and 51.4 g plant^{-1}) with the application of 75% RDF + 25 % N through pressmud + *Azotobacter* + PSB followed by 27 November sowing and 75% RDF + 25 % N through pressmud + *Azotobacter* + PSB during both the years and in pooled analysis. While the minimum dry matter accumulation at 45 DAS (5.1, 4.8, and 4.9 g plant^{-1}), 90 DAS (17.6, 14.9 and 16.3 g plant^{-1}) and at harvest stage (19.3, 16.2 and 17.8 g plant^{-1}) was observed on 7 December sowing in control plot during both the years and in pooled analysis. Therefore, the application of 75% RDF + 25 % N through pressmud + *Azotobacter* + PSB on sowing date 17 November was increased the dry matter accumulation at harvest 61.1, 64.0 and 65.5 per cent over date of sowing 17 November, 27 November, 7 December with the control plots in pooled analysis, respectively. Appropriate nutrient (mix of inorganic and organic sources of nutrients) supply with optimum time of sowing increased the higher dry matter accumulation as indicated by higher light interception, biomass production and nutrient uptake.

The significant dry matter accumulation increase under the first sowing on November 17 was due to earlier sowing provide more days to maturity (114 and 117 days during

Table 1: Interactive effect of sowing dates and nutrient sources on dry matter accumulation m^{-1} raw length at 45 DAS in Indian mustard

	2015-16			2016-17			Pooled		
Treatment	Nov 17	Nov 27	Dec 7	Nov 17	Nov 27	Dec 7	Nov 17	Nov 27	Dec 7
Control(Zero, NPKS)	5.7	5.3	5.1	5.4	5.0	4.8	5.6	5.1	4.9
100% RDF (NPKS)	9.4	8.8	8.6	9.0	8.4	8.2	9.2	8.6	8.4
100% RDF (NPKS) + *Azotobactor*	11.2	9.8	9.3	10.6	9.3	8.8	10.9	9.6	9.1
100% RDF (NPKS) + PSB	11.4	9.8	9.3	10.9	9.4	8.9	11.1	9.6	9.1
100% RDF (NPKS) + *Azotobactor* + PSB	12.1	10.7	9.8	11.5	10.2	9.3	11.8	10.5	9.6
75% RDF + 25 % N through PM+ *Azotobactor*	12.4	12.1	10.6	11.7	11.5	10.0	12.1	11.8	10.3
75% RDF + 25 % N through PM + PSB	12.7	12.2	10.8	12.1	11.6	10.2	12.4	11.9	10.5
75% RDF + 25 % N through PM +*Azotobactor* + PSB	14.1	13.4	12.3	13.4	12.7	11.7	13.8	13.0	12.0
SEm±	0.3			0.3			0.2		
CD (p=0.05)	0.8			0.7			0.5		

RDF = Recommended dose of fertilizers; NPKS = Nitrogen, Phosphorus, Potassium and Sulphur; PSB = Phosphorus solubilizing bacteria, PM= Pressmud, Nov. = November, Dec. = December

Table 2: Interactive effect of sowing dates and nutrient sources on dry matter accumulation m^{-1} raw length at 90 DAS in Indian mustard

	2015-16			2016-17			Pooled		
Treatment	Nov 17	Nov 27	Dec 7	Nov 17	Nov 27	Dec 7	Nov 17	Nov 27	Dec 7
Control(Zero, NPKS)	19.8	18.3	17.6	16.9	15.5	14.9	18.3	16.9	16.3
100% RDF (NPKS)	32.8	30.6	30.1	33.0	25.5	25.3	32.9	28.0	27.7
100% RDF (NPKS) + *Azotobactor*	39.0	34.1	32.3	40.2	29.2	27.4	39.6	31.7	29.9
100% RDF (NPKS) + PSB	39.8	34.3	32.5	40.5	29.4	27.5	40.1	31.8	30.0
100% RDF (NPKS) + *Azotobactor* + PSB	42.0	37.4	34.1	41.7	30.4	29.8	41.8	33.9	32.0
75% RDF + 25 % N through PM+ *Azotobactor*	43.0	42.3	36.8	42.0	35.1	31.4	42.5	38.7	34.1
75% RDF + 25 % N through PM + PSB	44.3	42.6	37.5	42.6	36.0	31.8	43.4	39.3	34.6
75% RDF + 25 % N through PM +*Azotobactor* + PSB	49.2	46.5	42.8	45.3	39.5	36.4	47.3	43.0	39.6
SEm±	0.9			0.6			0.6		
CD (p=0.05)	2.7			1.8			1.6		

RDF = Recommended dose of fertilizers; NPKS = Nitrogen, Phosphorus, Potassium and Sulphur; PSB = Phosphorus solubilizing bacteria, PM= Pressmud, Nov. = November, Dec. = December

Table 3: Interactive effect of sowing dates and nutrient sources on dry matter accumulation m^{-1} raw length at harvest in Indian mustard

Treatment	2015-16			2016-17			Pooled		
	Nov 17	Nov 27	Dec 7	Nov 17	Nov 27	Dec 7	Nov 17	Nov 27	Dec 7
Control(Zero, NPKS)	21.7	20.1	19.3	18.3	16.9	16.2	20.0	18.5	17.8
100% RDF (NPKS)	35.9	33.5	32.9	35.9	27.7	27.5	35.9	30.6	30.2
100% RDF (NPKS) + *Azotobacter*	42.7	37.4	35.4	43.7	31.8	29.8	43.2	34.6	32.6
100% RDF (NPKS) + PSB	43.6	37.6	35.6	44.1	31.9	30.0	43.8	34.7	32.8
100% RDF (NPKS) + *Azotobacter* + PSB	46.0	40.9	37.4	45.4	33.1	32.4	45.7	37.0	34.9
75% RDF + 25 % N through PM+ *Azotobacter*	47.1	46.3	40.3	45.7	38.1	34.2	46.4	42.2	37.3
75% RDF + 25 % N through PM + PSB	48.5	46.7	41.1	46.4	39.2	34.6	47.4	43.0	37.8
75% RDF + 25 % N through PM +*Azotobacter* + PSB	53.9	50.9	46.9	48.9	42.9	39.5	51.4	46.9	43.2
SEm±	1.0			0.7			0.6		
CD (p=0.05)	2.9			2.0			1.7		

RDF = Recommended dose of fertilizers; NPKS = Nitrogen, Phosphorus, Potassium and Sulphur; PSB = Phosphorus solubilizing bacteria, PM= Pressmud, Nov. = November, Dec. = December

both the years, respectively) and more growing degree days, which also provide optimum soil moisture condition and relatively suitable temperature during vegetative phase which help in sufficient photosynthesis to accumulate higher dry matter in the crop (Ozer, 2003, Kumar *et al*., 2013, Meena and Meena, 2017). Among the nutrient sources 75% RDF and 25% N through pressmud + *Azotobacter* + PSB increases dry matter accumulation up to maximum during both the years at all the growth stages. It may be due to addition of pressmud as source of organic matter and chemical fertilizers in combination to improve soil fertility by supplying major and a number of micro nutrients and having positive influence on physical and biological properties of soil (Kumar *et al*., 2017, Mandal and Sinha, 2004). Among biofertilizers, *Azotobacter* helps in provide nitrogen to crop and phosphorus solubilizing bacteria helps in providing sufficient phosphorus to fulfill the crop requirement (Pattam *et al*., 2017). While, later sown crop (November 27 and December 7) decreased dry matter accumulation with delay in sowing date due to facing low temperature at the time of emergence as well as at growth stage. Hence, the interactive effect of combining sowing dates and nutrient sources proved more advantageous than use of each component, independently.

Conclusion

Industrial by-products are the major sources of GHGs emission. While, their recycling can mitigate CO_2, N_2O and CH_4 emissions through composting and use as manure in agriculture, as carbon sequestration. Therefore, there is need for use byproducts eco-friendly, cost-effective though availability to farmers uses in agriculture and awareness of institutional, social, and economic importance. The result of the experiment showed that the sowing first (Nov 17) and nutrient source (75% RDF and 25% N through pressmud + *Azotobacter* + PSB) gave higher dry matter accumulation than other combinations. By the application of pressmud with inclusion of biofertilizers farmers can reduce the dose of chemical fertilizers, cost of cultivation, maintain soil health and increase their income.

References

Banjara TR, Pali GP, Kumar B and Kumar S. 2017. Tillage practices influence on growth, yield and economics of Toria (*B. rapa* var. Toria) under rainfed condition of Chhattisgarh. *J Oilseed Brassica* **8**: 163-167.

DES. 2017. Directorate of Economics and Statistics, Ministry of Agriculture, www.agri.com.

Gomez KA and Gomez AA. 1976. *Statistical Procedures for Agricultural Research, 2nd edn.* John Willey and

Sons Inc. New York, USA.

Gudadhe NN, Mankar PS, Khawale VS and Dongarkar KP. 2005. Effect of biofertilizers on growth and yield of mustard (*B. juncea* L.). *J Soils and Crops* **15:** 160-162.

Intergovernmental Panel on Climate Change. 2001. Third Assessment Report of the United Nations Framework Convention on Climate Change, Nov 7, Marrakech, Morocco.

Kumar S, and Meena RS. 2016. Influence of soil and air temperature on soil microbs under current climatic era. *Agri Sustain Dev*, **3**: 102-111.

Kumar S, Meena RS, Jinger D, Jatav HS and Banjara T. 2017. Use of pressmud compost for improving crop productivity and soil health. *Intl J Chem Studies* **5**: 384-389.

Kumar S, Sairam RK and Prabhu KV. 2013. Physiological traits for high temperature stress tolerance in *Brassica juncea*. *Indian J Plant Physiol* **18**: 89-93.

Lal R. 2004. Soil carbon sequestration impacts on global climate change and food security. *Sci* **304**: 1623-1626.

Lehmann J. 2007. A handful of carbon. *Nature* **447**: 143-144.

Mandal KG and Sinha AC. 2004. Nutrient management effects on light interception, photosynthesis, growth, dry-matter production and yield of Indian mustard (*B. juncea*). *J Agron Crop Sci* **190**: 119-129.

Meena H and Meena RS. 2017. Assessment of sowing environments and bio-regulators as adaptation choice for cluster bean productivity in response to current climatic scenario. *Bangladesh J Bot* **46**: 241-244.

Meena RS and Yadav RS. 2015. Yield and profitability of Groundnut *(Arachis hypogaea* L.) as influenced by sowing dates and nutrient levels with different varieties. *Legume Res* **38**: 791-797**.**

Meena RS, Bohra JS, Singh SP, Meena VS, Verma JP, Verma SK and Shiiag SK. 2016. Towards the prime response of manure to enhance nutrient use efficiency and soil sustainability a current need: A book review. *J Cleaner Prod* **112**: 1258-1260.

Meena RS, Meena PD, Yadav GS and Yadav SS. 2017. Phosphate solubilizing microorganisms, principles and application of microphos technology. *J Cleaner Product* **145**: 157-158.

Ozer H. 2003. Sowing date and nitrogen rate effects on growth, yield and yield components of two summer rapeseed cultivars. *Eur J Agron* **19**: 453-463.

Padalkar RC, Raut PD. 2016. Assessment of soil carbon level after application of pressmud and mulching regarding soil carbon sequestration. *Nature Env Pollution Technol* **15**: 601-604.

Pattam K, Pannu RK, Dhaka AK and Sharma KD. 2017. Effect of dates of sowing and nitrogen levels on growth and yield of Indian mustard. *Intl J Current Microbiol Appl Sci* **6**: 1029-1036.

Singh MP, Lallu, Singh NB. 2014. Thermal requirement of Indian mustard (*B. juncea*) at different phonological stages under late sown condition. *Indian J Plant Physiol* **19**: 238–243.

Singh RP, Pal Y and Singh H. 2011. Effect of organic and inorganic sources of nutrients on growth, yield and quality of Indian mustard (*B. juncea* L.) under late sown condition. *Pantnagar J Res* **9**: 308-310.

Tripathi MK, Chaturvedi S, Shuklaand DK and Saini SK. 2011. Influence of integrated nutrient management on growth, yield and quality of Indian mustard *(B. juncea* L.) in Tarai region of northern India. *J Crop and Weed* **7**: 104-107.

Uikey M, Nawalakhe SM and Kothikar RB. 2017. Effect of different meteorological weeks on yield parameters of mustard. *Intl J Adv Sci Eng Technol* **5**: 87-88.

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