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Effect of integrated nutrient management and mulching practices on yield and economics of Mustard (*Brassica juncea* L.)

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Abstract
An experiment on "Effect of integrated nutrient management and mulching on yield and quality of Mustard (*Brassica juncea* L.) and soil quality in partially reclaimed Sodic Soil.'' was carried out during *Rabi* session 2018-19 and 2019-20 at Agronomy Research Farm, A.N.D.U.A&T. Kumarganj, Ayodhya (U.P.). The experiment consists of fourteen treatments were laid out in Randomized Block Design (RBD) with three replications. As per experiment the results revealed that the yield parameters were significantly influenced by different integrated nutrient management and mulching practices. The maximum grain and straw yield (21.05, 22.08 q ha^{-1} and 49.42, 51.43 q ha^{-1}) were found when apply 75% NPK+ N-25% (FYM) +S @40 kg + Mulching @5 t/ha^{-1} (T_{13}) respectively, which was at par with the treatment T_{14} and T_6, T_{14}, T_{11}, T_7, T_{12}. While significantly superior over rest of the treatments. In case of economic of different treatments, the maximum gross return and net return (Rs. 88509, 92835 ha^{-1} and 49408, 52309 ha^{-1} respectively in both years found with the treatment T_{13} -75% NPK+ N-25% (FYM) +S @40 kg + Mulching @5 t/ha^{-1}. However maximum B:C ratio (1.32 and 1.45) was recorded with the application of T_6 - 75% NPK+ N-25% (FYM) +S @40 kg + NO Mulching and with respective years.

Keywords: INM, mulching, yield and economic, mustard

Introduction
Mustard [*Brassica juncea* (L.)] is important Rabi oilseed crop which belongs to family "Cruciferae". The oil content in mustard seeds varies from 37-49 percent the seeds are highly nutritive containing 38-57% eruric acid, and 27% oleic acid (Bhowmik *et al*., 2014) [1]. The oil cake left after extraction is utilized as cattle feed and manure containing 5.1% N, 1.8% P_2O_5 and 1.1% K_2O. This is a potential crop in winter *Rabi* season due to its wider adaptability and suitability to exploit residual moisture Mukherjee (2010) [9]. India is one of the largest oilseeds producing country that covers one fifth of the entire area under this group of crops and also yields one-fifth of the total oilseed production in the world. Globally, rapeseed mustard is grown by more than sixty nations including India. In terms of average yield, India (1128 kg/ha) is about 63% below the world average yield (1840 kg/ha) of rapeseed and mustard. In India, it is cultivated by more than 26 states (including Union Territories) with Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana and West Bengal being that major players in terms of area and production of rapeseed–mustard DRMR (2020) [3] and DOD (2020) [2]. With the adoption of intensive farming the farmer have shifted from organic to inorganic high analysis S-free fertilizer leading to more widespread and more intense S deficiency in Indian soil in early 1990's estimated to occur in about 130 District and recently about 45% districts of our country so more than 40% S deficiency Tandon (1991) [11]. Generally, pulse and oilseed crops are raised under rainfed conditions with low input and poor management practices leading to lower productivity level Lal *et al.*, (2015) [7]. Yield potentials of the crop, can be realized by balanced and efficient use of organic and inorganic sources of nutrient Meena *et al.*, (2016) and also use of suitable agronomic package practices to crop. Imbalanced nutrition is one of the important constraints towards higher mustard productivity, oil content and other quality parameters Lal *et al.*, (2016) [6].

Material and Methods
A field experiment was carried out during *Rabi* season of 2018-19 and 2019-20 at the experimental farm (26°47' N latitude and 82°12' E longitude) A.N.D.

University of Agriculture and Technology Kumarganj located at an altitude of 113 m above the mean sea level in Ayodhya district of Uttar Pradesh. The experimental site is characterized by sub- tropical climate with extreme temperature during summer (up to 46^0C) and winter (as low 3^0C) and rainfall (1000mm and most which is received in rainy season). The soil is silty loam, well drained, having pH (8.20), EC (0.25 dS/m), organic carbon (0.33%) available N (137 kg ha^{-1}), available P (15.35 kg ha^{-1}), available K (249.25 kg ha^{-1}), available sulphur (15.35 ppm) at commencement of the experiment. The present investigation entitled that "Effect of integrated nutrient management and mulching on yield and quality of Mustard (*Brassica juncea* L.) and soil quality in partially reclaimed Sodic Soil.'' The experiment was consists of fourteen treatments i.e. T_1- Control (NO NPK + NO Mulching), T_2- 100% NPK + NO Mulching, T_3- 75% NPK + N-25% (FYM) + NO Mulching, T_4- 100% NPK+ S @40 kg + NO Mulching, T_5 -100% NPK+ $ZnSO_4$ @25 kg + NO Mulching, T_6 - 75% NPK+ N-25% (FYM) +S @40 kg + NO Mulching, T_7 -75% NPK+ N-25% (FYM) + $ZnSO_4$ @25kg + NO Mulching, T_8- Control + mulching @5 t/ha^{-1}, 100% NPK + Mulching @5t/ha^{-1}, T_{10} - 75% NPK + N-25% (FYM) Mulching @5 t/ha^{-1}, T_{11} - 100% NPK+ S @40 kg + Mulching @5 t/ha^{-1}, T_{12} -100% NPK+ $ZnSO_4$ @25 kg + Mulching @5 t/ha^{-1}, T_{13}-75% NPK+ N-25% (FYM) +S @40 kg + Mulching @5 t/ha^{-1} and T_{14} -75% NPK+ N-25% (FYM) + $ZnSO_4$ @25kg + Mulching @5 t/ha^{-1} treatments were laid out in Randomized Block Design (RBD) with three replications. The variety Varuna was shown proper moisture stage on 20 oct., 2018-19 and 27 oct., 2019-20. Mustard seeds were sown in line at the distance of 45 cm row to row and plant to plant 15 cm with the help of *kudal.* The seed rate was used @5 kg ha^{-1}. Fertilizer Nitrogen, phosphorus and potassium were applied in the forms of Urea, SSP and Muriatic of potash @ 80, 40 and 20 kg ha^{-1}, respectively. Full dose of phosphorus, potassium and half dose of nitrogen were applied as Basel dressing at the time of sowing and rest half dose of nitrogen was applied as two split doses at the time of first irrigation and second irrigation.

Harvest index is an economic yield expressed as percentage of biological yield and calculated as formula given by Donald and Hamblin (1976)

$$\text{Index Harvest (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Net return (Rs. ha^{-1}) was calculated by deducting the cost of cultivation from the gross return of the individual treatments.

Net Return (Rs. ha^{-1}) = Gross return – Cost of cultivation

Benefit-cost ratio (Rs./re-invested) was calculated with net return dividing by cost of cultivation.

$$\text{B: C ratio} = \frac{\text{Net return (Rs./ha.)}}{\text{Cost of cultivation (Rs./ha.)}}$$

Results and Discussion

Grain and straw yield significantly influenced by the use of integrated nutrient management system and mulching (Table 1). Among the treatments, maximum seed (21.05 and 22.08 q ha^{-1}) and stover (49.42 and 51.43 q ha^{-1}) were recorded under treatment T_{13}-75% NPK+ N-25% (FYM) +S @40 kg + Mulching @5 t/ha^{-1} in respective years 2018-19 and 2019-20. Which was found statistically at par with T_{14} -75% NPK+ N-25% (FYM) + $ZnSO_4$ @25kg + Mulching @5 t/ha^{-1}having yield (19.57 and 21.17 q ha^{-1}) and significantly superior over rest treatments in respective years 2018-19 and 2019-20. The yield Productivity of crop is collectively determined by vigour of the vegetative growth and yield attributes which resulted in higher seed and straw yields. The increase in yield was further attributed to better translocation of photosynthesis from source to sink due to higher uptake of N, P, K and S. Which was responsible for quick and easy translocation of photosynthesis. Contrary to this, nutrients stress and moisture due to reduced absorption of nutrients in control plots provided minimum seed and straw yields due to poor growth and yield attributing characters. Similar finding has been given by (Singh *et al.* 2020 and Kumar S. T. 2020) [10, 5].

The experimental results have been shown in (table 2) found based on input output analysis, the cost of cultivation (Rs. ha^{-1}), gross return (Rs ha^{-1}), net return (Rs. ha^{-1}) and B:C ratio were worked out to ensure the economical feasibility for adoption of recommendations. As par observed data the maximum gross return (Rs. 88509.00 and 92835.00 ha^{-1}) was computed when applied 75% NPK+ N-25% (FYM) +S @40 kg + Mulching @5 t/ha^{-1} (T_{13}).This might be due to obtained more grain & straw yield. This might be due to no excess manure/fertilizer was concluded with treatment. While maximum cost of the cultivation (Rs. 39101.00 and 40526.00 ha^{-1}) was calculated under the treatment T_{13}-75% NPK+ N-25% (FYM) +S @40 kg + Mulching @5 t/ha^{-1}. Comparable finding was likewise announced by (Dwivedi and Puhup 2019 and Singh *et al.* 2020) [4, 10].

Table 1: Effect of INM and mulching practices on seed yield (q ha^{-1}), stover yield (q ha^{-1}) and harvest index (%) of mustard

Treatments	Seed yield (q ha^{-1})		Stover yield (q ha^{-1})		Harvest index (%)	
	2018-19	2019-20	2018-20	2018-19	2018-20	2019-20
T_1- Control (NO NPK + NO Mulching)	10.05	10.41	31.59	32.23	24.13	24.41
T_2- 100% NPK + NO Mulching	14.72	15.96	37.93	40.75	27.95	28.14
T_3- 75% NPK + N-25% (FYM) + NO Mulching	15.17	16.42	40.66	41.25	27.31	28.47
T_4- 100% NPK+ S @40 kg + NO Mulching	16.22	18.42	42.30	43.23	27.71	29.87
T_5 -100% NPK+ $ZnSO_4$ @25 kg + NO Mulching	15.22	17.02	41.31	42.76	26.92	28.47
T_6 - 75% NPK+ N-25% (FYM) +S @40 kg + NO Mulching	18.89	19.77	47.17	49.08	28.59	28.71
T_7 -75% NPK+ N-25% (FYM) + $ZnSO_4$ @25kg + NO Mulching	17.41	18.86	43.61	46.58	28.53	26.82
T_8- T_1 + Mulching @5 t/ha^{-1}	11.78	12.30	34.23	35.48	25.60	25.74
T_9-T_2 + Mulching @5 t/ha^{-1}	16.88	18.27	40.18	43.19	29.58	29.72
T_{10} -T_3 + Mulching @5 t/ha^{-1}	17.33	18.73	42.91	44.11	28.76	29.80
T_{11} - T_4 + Mulching @5 t/ha^{-1}	18.38	20.53	44.55	45.58	29.20	29.99
T_{12} -T_5 + Mulching @5 t/ha^{-1}	17.38	19.13	43.56	45.11	28.51	29.77
T_{13}-T_6 + Mulching @5 t/ha^{-1}	21.05	22.08	49.42	51.43	29.90	30.87
T_{14} -T_7 + Mulching @5 t/ha^{-1}	19.57	21.17	45.86	48.93	29.87	30.19

SE(m)±	0.73	0.76	2.04	2.07	_	_
CD at 5%	2.14	2.22	6.01	6.15	_	_

Table 2: Effect of INM and mulching practices on economics of mustard crop

Treatments	Cost of cultivation (Rs ha^{-1})		Gross returns (Rs ha^{-1})		Net returns (Rs ha^{-1})		B:C ratio	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
T_1- Control (NO NPK + NO Mulching)	26016	27441	42273	45868	16257	18427	0.62	0.67
T_2- 100% NPK + NO Mulching	29596	31021	61900	70306	32304	39285	1.09	1.26
T_3- 75% NPK + N-25% (FYM) + NO Mulching	31301	32726	63795	72331	32494	39605	1.03	1.21
T_4- 100% NPK+ S @40 kg + NO Mulching	32396	33821	68209	81134	35913	47313	1.10	1.39
T_5 -100% NPK+ $ZnSO_4$ @25 kg + NO Mulching	31096	32521	64007	74974	32911	42453	1.05	1.30
T_6 - 75% NPK+ N-25% (FYM) +S @40 kg + NO Mulching	34101	35526	79432	87086	45331	51560	1.32	1.45
T_7 -75% NPK+ N-25% (FYM) + $ZnSO_4$ @25kg + NO Mulching	32801	34226	73209	83077	40408	48851	1.23	1.42
T_8- T_1 + Mulching @5 t/ha^{-1}	31016	32411	49476	51731	18460	19320	0.59	0.59
T_9-T_2 + Mulching @5 t/ha^{-1}	34596	36021	70976	76820	36380	40799	1.05	1.13
T_{10} -T_3 + Mulching @5 t/ha^{-1}	36301	37726	72872	78754	36571	41028	1.00	1.08
T_{11} - T_4 + Mulching @5 t/ha^{-1}	37396	38821	77285	86317	39889	47496	1.06	1.22
T_{12} -T_5 + Mulching @5 t/ha^{-1}	36096	37521	73083	80436	36987	42915	1.02	1.14
T_{13}-T_6 + Mulching @5 t/ha^{-1}	39101	40526	88509	92835	49408	52309	1.26	1.29
T_{14} -T_7 + Mulching @5 t/ha^{-1}	37801	39226	82286	89911	44485	50685	1.17	1.29

Summary and Conclusion

As par the data presented in table 1 and table 2 the results may be concluded that, among the integrated nutrient management system and mulching practices, T_{13}-75% NPK+ N-25% (FYM) +S @40 kg + Mulching @5 t/ha^{-1} proved to found better for yield. However, maximum net return(Rs. 49408 and 52309 ha^{-1}) was found T_{13}-T_6 + Mulching @5 t/ha^{-1} and B:C ratio(1.32 and 1.45) were calculated under the treatment T_6 - 75% NPK+ N-25% (FYM) +S @40 kg + NO Mulching as compare to other treatments.

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