

**EFFECT OF MACRO-NUTRIENT AND FARM YARD MANURE ON  
PRODUCTIVITY AND PROFITABILITY OF MUSTARD (*BRASSICA  
JUNCEA L.*) IN WESTERN UTTAR PRADESH, INDIA**

**ABSTRACT**

A field experiment was conducted during *rabiseason* of 2015-16 at agricultural farm of IFTM University, Lodhipur Rajput, Moradabad (UP), India, to evaluate the effect of NPK, Sulphur and FYM on growth and yield of mustard (*Brassica juncea L.*) in western Uttar Pradesh. The experiment consisted ten treatment combination was laid out in randomized block design with three replications. The result revealed that the highest growth and yield attributing characters recorded with the application of 75% NPK in combination with 40 kg S and 10 MT FYM ha<sup>-1</sup>. Highest plant height (174.63 cm), number of branches plant<sup>-1</sup> (24.47), dry weight (21.47 g), number of siliquae plant<sup>-1</sup> (381.40), 1000-seed weight (5.52 g), seed yield (1541.5 kg ha<sup>-1</sup>) and stover yield (5161.0 kg ha<sup>-1</sup>) was recorded the application of 75% NPK in combination with 40 kg S and 10 MT FYM ha<sup>-1</sup>. Net return (Rs. 33119.4) and B: C ratio (1.04) was significantly differ from control. Oil and protein content was significantly influenced with the application of Sulphur and FYM. Significantly higher oil content was recorded at 75 % NPK along with 40 kg S and 10 MT FYM ha<sup>-1</sup>. Protein content was significantly higher in 75 % NPK along with 40 kg S and 10 MT FYM ha<sup>-1</sup>.

**Key words:** NPK, Sulphur, FYM, Mustard, Yield, Quality.

**INTRODUCTION**

Indian mustard (*Brassica juncea L.*) is a major *rabioilseed* crop belongs to the family of *Cruciferae*. Rapeseed and mustard are important oilseed crops which ranks third in vegetable oils after soybean and palm (USDA, 2011). Rapeseed-mustard (*Brassica juncea L.*) in world production India ranks third after Canada and China. In India, soybean, groundnut and rapeseed-mustard are the major oilseed crops contributing nearly 88% of the total production. Its seed contains 37- 49% oil (Singh *et al.*, 2014). The oil and seeds are used as condiment in the preparation of pickles and for flavoring curies and vegetables. The mustard oil is utilized for

30 human consumption throughout northern India in cooking and frying purposes. It is also used in  
31 the preparation of hair oils and medicines. The oil cake is used as cattle feed and manure, which  
32 contains about 4.9 percent nitrogen, 2.5 percent phosphorus and 1.5% potash (Singh *et al.*,  
33 2014).

34 Mustard is the third most important oilseed crops after soybean and groundnut in India  
35 occupying 6.65 million-hectare acreage, 7.88million tonnes production and 1,185 kg ha<sup>-1</sup>  
36 productivity (Anonymous, 2015).Major states producing mustard are Rajasthan, Punjab,  
37 Haryana, Uttar Pradesh, Bihar, Madhya Pradesh, West Bengal and Gujarat. Rajasthan ranks first  
38 in both area and total production of mustard. Gujrat has the highest productivity (1485 kg ha<sup>-1</sup>) of  
39 rapeseed and mustard.Among the different states, Uttar Pradesh alone produces about 20 percent  
40 of total rapeseed and mustard production in India (Singh *et al.*, 2014).The area under mustard in  
41 Uttar Pradesh are 0.66 million hectares with production of 0.74 million tones and productivity  
42 1112 kg ha<sup>-1</sup>(Anonymous, 2015).India's per capita edible oil consumption is currently estimated  
43 at 17.18 kgand vegetable oil consumption of the world average is 24.86 kg (USDA, 2016).

44 The continuous mining of nutrients from soils coupled with inadequate and imbalanced  
45 fertilizer use has resulted in emergence of multi nutrient deficiencies. Mainly at least six  
46 nutrients (N, P, K, S, Zn and B) were observed deficient in Indian soils. Sulphur is involved  
47 directly or indirectly in different metabolic pathways of plants and play important role in the  
48 metabolic activities. The involvement of sulphur is an important component of several enzymes  
49 and metabolic processes in plants (Lakkineni and Abrol, 1994).Farm yard manure (FYM)  
50 improves the soil physico-chemical properties along with direct release of macro as well as  
51 micronutrient; ultimately the crop yields increase (Singh *et al.*, 2015).

52 The objective of this study was to examine the effect of macro-nutrients and FYM on  
53 mustard productivity and profitability in western Uttar Pradesh, India.

## 54 MATERIALS AND METHODS

55 The present investigation was conducted at agricultural farm of IFTM University,  
56 Lodipur Rajput Moradabad (UP), India during *rabiseason* of 2015-2016. The climate of  
57 Moradabad region comes under central plain zone climatic conditions. This area has been  
58 characterized by mild winters and moderate summers associated with high relative humidity  
59 during the rainy season. The soil of the experimental farm was sandy loam intexture, low in

60 organic carbon(0.46%)and neutral (7.1 pH) in soil reaction, low in available nitrogen (146.4 kg  
61 ha<sup>-1</sup>), low in available phosphorus (15.6 kg ha<sup>-1</sup>) and medium in available potassium (261.3 kg  
62 ha<sup>-1</sup>). The experiment was laid out in Randomized Block Design (Fisher, 1947) with three  
63 replications. Ten treatment combinations *viz.* T<sub>1</sub>(control), T<sub>2</sub>(120 % NPK), T<sub>3</sub>(120% NPK+ 20kg  
64 ha<sup>-1</sup> Sulphur), T<sub>4</sub>(120% NPK+ 40kg ha<sup>-1</sup> Sulphur), T<sub>5</sub>(100 % NPK), T<sub>6</sub>(100 % NPK + 20kg ha<sup>-1</sup>  
65 Sulphur), T<sub>7</sub>(100 % NPK + 40kg ha<sup>-1</sup> Sulphur), T<sub>8</sub>(75 % NPK + 10 t ha<sup>-1</sup> FYM), T<sub>9</sub>(75 % NPK +  
66 20kg ha<sup>-1</sup> Sulphur + 10 t ha<sup>-1</sup> FYM) and T<sub>10</sub>(75 % NPK + 20kg ha<sup>-1</sup> Sulphur + 10 t ha<sup>-1</sup> FYM).  
67 The recommended doses of NPK was applied at the rate of 120 kg N, 60 Kg P<sub>2</sub>O<sub>5</sub> and 60 kg K<sub>2</sub>O  
68 ha<sup>-1</sup>.

69 The crop variety JKMS-8001 was sown in rows 40 cm apart on 7<sup>th</sup> October 2015 and  
70 harvested on 20<sup>th</sup> February, 2016. Intercultural operations were done as and when required.  
71 Fertilizers applied are Urea (46% N), di-ammonium phosphate (18 % N and 46% P<sub>2</sub>O<sub>5</sub>), muriate  
72 of potash (60 % K<sub>2</sub>O) and elemental sulphur (100% S). The 50 percent dose of nitrogen and full  
73 dose of phosphorus and potash was applied as basal. Sulphur also applied as basal as per the  
74 treatment. Remaining 50 percent dose of nitrogen was applied as top dressing. Well decomposed  
75 farm yard manure was applied 30 days before sowing as per treatments and mixed well with the  
76 soil. Thinning and manual weeding was completed within 20 days of sowing. Mustard was  
77 irrigated twice. During crop period, a total rainfall of 114 mm was received. Imidacloprid, a  
78 systemic insecticide, was sprayed @ 0.5 ml liter<sup>-1</sup> of water on the crop, as a prophylactic measure  
79 to avoid the aphid infestation. All the observation was recorded on individual plant basis and  
80 average. Observations were recorded on various growth parameters, yield components (*viz.* Plant  
81 height, number of branches plant<sup>-1</sup>, dry weight, number of siliquae plant<sup>-1</sup>, number of seeds  
82 siliquae<sup>-1</sup> and 1000- seed weight) and yield. Protein content in seed was determined multiplying  
83 N content with a constant factor 6.25 (A.O.A.C, 1960) and oil content determined by Nuclear  
84 Magnetic Resonance technique (Tiwari *et al.*, 1974).

85 All the data were statistically analyzed using analysis of variance (ANOVA) technique as  
86 applicable to randomized block design (Gomez and Gomez, 1984). The significance of the  
87 treatment effect was determined using F-test, and to determine the significance of the difference  
88 between the means of the two treatments, least significant differences (LSD) were estimated at  
89 the 5 % probability level.

## 90 RESULTS AND DISCUSSION

### 91 GROWTH ATTRIBUTES

92 The growth parameters indicating significant difference with respect of plant height,  
93 number of branches plant<sup>-1</sup>, dry weight (Table-1). Plant height is a good index of crop vigour. In  
94 general, plant height increased with the advancement of plant age up to harvest. Replacement of  
95 NPK with FYM when combined with sulphur had marked effect on the plant height at various  
96 growth stages. The plant height was significantly higher with the application of T<sub>10</sub> (75%  
97 NPK+40 kg S ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>) which were at par with T<sub>9</sub> (75% NPK+20 kg S ha<sup>-1</sup> + 10 t  
98 FYM ha<sup>-1</sup>). Application of farm yard manures along with other chemical fertilizers and sulphur  
99 proves better result. That might be due to the role of FYM in enhancing soil health, quality and  
100 biological properties of soil. FYM has synergistic effect and helping in mineralization of applied  
101 nitrogen and phosphorus, which might help in enhancing of growth parameters. Similar result  
102 also reported by Jatet *al.* (2012). Similar to plant height, number of branches plant<sup>-1</sup> increased  
103 with the advancement of plant age up to harvest. Replacement of NPK with FYM when  
104 combined with sulphur had marked effect on the number of branches at various growth stages.  
105 This indicates that NPK requirement of the crop may be replaced by 25% with addition of other  
106 nutrient sources for branches of mustard. Our findings corroborate with the findings of Kumar *et*  
107 *al.* (2016).

108 **Table: 1: Effect of NPK, S and FYM on growth and yield attributes**

Treatments	Plant height (cm)	No of branches plant <sup>-1</sup>	Dry wt. (g)	No of Siliquae plant <sup>-1</sup>	No of seeds siliquae <sup>-1</sup>	1000-seed weight (g)
Control	135.71c	15.57d	11.8b	211.67d	11.63b	4.50c
120% NPK	164.43b	20.67c	14.2b	264.10cd	12.33b	4.62bc
120% NPK + 20 kg S ha <sup>-1</sup>	170.81ab	25.67ab	17.87ab	279.60bc	13.60ab	4.57c
120% NPK + 40 kg S ha <sup>-1</sup>	173.81a	27.47a	15.23b	265.67c	13.50ab	4.46
100 % NPK	163.58b	23.27bc	19.67a	240.80cd	15.27a	4.64bc
100% NPK + 20 kg S ha <sup>-1</sup>	166.42b	23.80b	13.92b	249.93cd	13.43ab	5.61a

100% NPK + 40 kg S ha <sup>-1</sup>	167.71b	23.53bc	18.47ab	318.47b	13.73ab	4.96b
75% NPK + 10 t FYM ha <sup>-1</sup>	165.44b	25.47ab	19.27ab	375.10a	14.77a	5.41a
75% NPK +20 kg S ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup>	174.10a	24.53ab	20.60a	369.20a	15.70a	5.46a
75% NPK +40 kg S ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup>	174.63a	24.47ab	21.47a	381.40a	14.10ab	5.52a
SE(m)	1.56	1.04	1.37	14.35	0.78	0.12
LSD (p=0.05)	4.68	3.11	4.10	42.98	2.33	0.35

## 109 YIELD ATTRIBUTES

110 All yield attributes were affected significantly with the application different nutrient  
111 levels. Number of siliqua plant<sup>-1</sup> increased significantly with replacement of NPK with FYM  
112 alone and with addition of sulphur. Therefore, application of FYM and sulphur can be  
113 responsible for causing higher photosynthesis and assimilation rates lending to significant  
114 increase in siliqua number on plants as compared to other treatments. The seeds siliqua<sup>-1</sup> varied  
115 with combination of different nutrients, due to sufficient dose of nutrients available during the  
116 entire period of crop growth for better vegetative growth and development of crop. The lowest  
117 test weight (4.50 g) in control plots is considerable to prove the effect of best treatment  
118 combinations. It might be due to direct involvement of number of branches, siliqua plant<sup>-1</sup> and  
119 grains siliqua<sup>-1</sup> in conjugation with consequent effect of fertilization. Similar results have also  
120 been reported by Prasad and Shivay (2016), Singh & Kumar (2017), Singh *et al.*(2014) and  
121 Kumar *et al.* (2001).

## 122 SEED AND STOVER YIELD

123 The data in table 2 proved that the 75 % NPK with Sulphur and FYM recorded significantly  
124 highest seed and stover yield per ha over the other treatment. This might be due to deprive of  
125 nutrients former and supply over critical level in later treatment, which increase siliquae plant<sup>-1</sup>,  
126 number of seeds siliquae<sup>-1</sup> and 1000-seed weight. These results are in close conformity with the

127 findings of Piri and Sharma (2006).The Stover yield was found significantly variable according  
 128 to the treatments. That might be possible because plants received nutrients from appropriate  
 129 sources to give their full potential for influencing the harvest index of mustard. It seems that the  
 130 better utilization efficiency of NPK, S and FYM in response on optimum these nutrients  
 131 reflected in greater vegetative growth and increase growth enzymatic activity. These results are  
 132 in close conformity with the findings of Faujdar *et al.* (2008), Neha *et al.* (2014), Kumar *et al.*  
 133 (2001).Integration of FYM increased the cost of treatment,therefore, reduced the system net  
 134 returns as compared to chemical fertilizers, but if we replace the doses of chemical fertilizers with  
 135 FYM it compensates total cost of inputs (Singh *et al.*,2014).

136 **Table 2:Effect of NPK, S and FYM on yield and economics**

Treatments	Seed Yield (kg ha <sup>-1</sup> )	Stover Yield (kg ha <sup>-1</sup> )	Harvest index (%)	Gross return (Rs. ha <sup>-1</sup> )	Net return (Rs. ha <sup>-1</sup> )	B: C ratio
Control	812.6c	3183.47c	20.30	34841.41	10391.41	0.43
120% NPK	1273.8b	4386.40b	22.50	53710.2	24612.2	0.85
120% NPK + 20 kg S ha <sup>-1</sup>	1430.9ab	4982.13ab	22.30	60416.5	30518.5	1.02
120% NPK + 40 kg S ha <sup>-1</sup>	1421.0ab	5409.33a	20.84	60691	29993	0.98
100 % NPK	1207.1b	4413.60b	21.45	51283.1	23095.1	0.82
100% NPK + 20 kg S ha <sup>-1</sup>	1356.3b	4515.20b	23.11	56955.9	27967.9	0.96
100% NPK + 40 kg S ha <sup>-1</sup>	1469.6ab	4912.53a	23.11	61744	31956	1.07
75% NPK + 10 t FYM ha <sup>-1</sup>	1280.8b	4933.07ab	20.63	54789.21	24546.21	0.81
75% NPK +20 kg S ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup>	1514.3ab	5381.33a	21.98	64101.1	33058.1	1.06
75% NPK +40 kg S ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup>	1546.5a	5161.60a	23.05	64962.9	33119.9	1.04
SE(m)	59.73	182.29	1.10			
LSD (p=0.05)	178.85	545.80	NS			

138 **OIL AND PROTEIN CONTENT**

139 The oil content in seed at par with the increasing of NPK levels whereas, consecutive  
 140 addition of sulphur and FYM increased oil content. Crop fertilized with 75% recommended dose  
 141 of fertilizer with sulphur and FYM recorded higher oil content than control. The lower oil  
 142 content in control and other treatment may be due to more availability of nitrogen which,  
 143 increase the protenious substances in the seeds.Higher availability of nitrogen may be resulted a  
 144 higher portion of photosynthates is delivered to protein formation leaving a potential deficiency  
 145 of carbohydrates to be degraded to acetyl co-enzyme A for the synthesis of fatty acids. These  
 146 results are close conformity with the findings of Tripathi *et al.* (2011). The increase in oil content  
 147 with Sulphur fertilization may be attributed to its role in oil synthesis and increase in glucosides  
 148 (Tripathi *et. al.*, 2010, Kumar *et al.*, 2006 and Singh *et. al.*, 2010). Availability of Sulphur  
 149 increased the conversion of fatty acid metabolites to the end product of fatty acid (Jain *et. al.*,  
 150 1996 and Singh & Pal, 2011).

151 It was found that the application of Sulphur and FYM resulted significant increase in  
 152 protein content. Sulphur being a constituent of S containing amino acids and increased in protein  
 153 content. Significant increase in protein content may be due to the increase in availability of  
 154 Sulphur and nitrogen resulted in protein synthesis. These findings are close agreement with  
 155 Kumar *et al.*(2006).

156 **Table 3: Effect of NPK, S and FYM on oil and protein content**

<b>Treatments</b>	<b>Oil content (%)</b>	<b>Protein content (%)</b>
Control	41.76d	21.20c
120% NPK	43.72c	23.36ab
120% NPK + 20 kg S ha <sup>-1</sup>	44.04bc	23.75a
120% NPK + 40 kg S ha <sup>-1</sup>	44.36b	23.95a
100 % NPK	44.37b	21.15c
100% NPK + 20 kg S ha <sup>-1</sup>	43.99bc	22.53b
100% NPK + 40 kg S ha <sup>-1</sup>	45.30a	23.81a

75% NPK + 10 t FYM ha <sup>-1</sup>	45.59a	23.53ab
75% NPK +20 kg S ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup>	45.57a	24.08a
75% NPK +40 kg S ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup>	45.76a	24.28a
SE(m)	0.171	0.367
LSD (P=0.05)	0.511	1.098

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## 158 CONCLUSIONS:

159 Based on results obtained from the present investigation, it can be concluded that  
 160 application of DAP 65 kg ha<sup>-1</sup>, Urea 104 kg ha<sup>-1</sup>, MOP 50 kg ha<sup>-1</sup>, FYM 10 t ha<sup>-1</sup> and Sulphur 20  
 161 kg ha<sup>-1</sup> were proved to be most suitable dose for achieving higher growth and yield of mustard  
 162 crop along with sustainable soil health for the farmers of western Uttar Pradesh.

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