Original Research Article

EFFECT OF NPK, SULPHUR AND FYM ON GROWTH AND YIELD OF MUSTARD (*BRASSICA JUNCEA* L.) IN WESTERN UTTAR PRADESH

ABSTRACT

A field experiment was conducted during *rabi* season 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^{-1} was significantly higher over other treatment. Highest plant height (174.63 cm), number of branches plant^{-1} (24.47), dry weight (21.47 g), number of siliquae plant^{-1} (381.40), 1000-seed weight (5.52 g), seed yield (1541.5 kg ha^{-1}) and stover yield (5161.0 kg ha^{-1}). 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 % RDF along with 40 kg S and 10 MT FYM ha^{-1}. Protein content was significantly higher in 75 % RDF along with 40 kg S and 10 MT FYM ha^{-1}.

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

INTRODUCTION

Indian mustard (*Brassica juncea* L.) is a major *rabi* oilseed 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 per cent of the total production. Its seed contains 37- 49 percent 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 human consumption throughout northern India in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. The oil cake is used as cattle feed and manure, which contains about 4.9 percent nitrogen, 2.5 percent phosphorus and 1.5% potash (Singh *et al*., 2014 and Singh, 1998).

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

The continuous mining of nutrients from soils coupled with inadequate and imbalanced fertilizer use has resulted in emergence of multi nutrient deficiencies. Mainly at least six nutrients (N, P, K, S, Zn and B) were observed deficient in Indian soils. Sulphur is involved directly or indirectly in different metabolic pathways of plants and play important role in the metabolic activities. The involvement of sulphur is an important component of several enzymes and metabolic processes in plants (Lakkineni and Abrol, 1994). Farm yard manure (FYM) improves the soil physico-chemical properties along with direct release of macro as well as micronutrient; ultimately the crop yields increase (Bhatia and Shukla, 1982**)**.

MATERIALS AND METHODS

The present investigation was conducted at agricultural farm of IFTM University, Lodipur Rajput Moradabad (UP), India during *rabi* season of 2015-2016. The experimental material for the present investigation comprised of mustard. The climate of Moradabad region comes under central plain zone climatic conditions. This area has been characterized by mild winters and moderate summers associated with high relative humidity during the rainy season. The soil of the experimental farm was sandy loam in texture, low in organic carbon (0.46%) and neutral (7.1 pH) in soil reaction, low in available nitrogen (146.4 kg ha^{-1}), low in available phosphorus (15.6 kg ha^{-1}) and medium in available potassium (261.3 kg ha^{-1}). The experiment was laid out in Randomized Block Design (Fisher, 1947) with three replications. Ten treatment combinations *viz.* T_1(control), T_2(120 % NPK), T_3(120% NPK+ 20kg ha^{-1} Sulphur), T_4(120% NPK+ 40kg ha^{-1} Sulphur), T_5(100 % NPK), T_6(100 % NPK + 20kg ha^{-1} Sulphur), T_7(100 % NPK + 40kg ha^{-1} Sulphur), T_8(75 % NPK + 10 t ha^{-1} FYM), T_9(75 % NPK + 20kg ha^{-1} Sulphur + 10 t ha^{-1} FYM) and T_{10}(75 % NPK + 20kg ha^{-1} Sulphur + 10 t ha^{-1} FYM).

The crop variety JKMS-8001 was sown in rows 40 cm apart on 7th October 2015 and harvested on 20th February, 2016. Intercultural operations were done as and when required. The 50 percent dose of nitrogen and full dose of phosphorus and potash was applied as basal. Sulphur also applied as basal as per the treatment. Remaining 50 percent dose of nitrogen was applied as top dressing. Well decomposed farm yard manure was applied 30 days before sowing as per treatments and mixed well with the soil. Thinning and manual weeding was completed within 20 days of sowing. Mustard was irrigated twice. During crop period, a total rainfall of 114 mm was received. Imidacloprid, a systemic insecticide, was sprayed @ 0.5 ml $liter^{-1}$ of water on the crop, as a prophylactic measure to avoid the aphid infestation. All the observation was recorded on individual plant basis and average. Observations were recorded on various growth parameters, yield components and yield. Protein content in seed was determined multiplying N content with a constant factor 6.25 (A.O.A.C, 1960) and oil content determined by Nuclear Magnetic Resonance technique.

All the data were statistically analyzed using analysis of variance (ANOVA) technique as applicable to randomized block design (Gomez and Gomez, 1984). The significance of the treatment eff ect was determined using F-test, and to determine the significance of the diff erence between the means of the two treatments, least significant diff erences (LSD) were estimated at the 5 % probability level.

RESULTS AND DISCUSSION

GROWTH ATTRIBUTES

The growth parameters indicating significant difference with respect of plant height, number of branches $plant^{-1}$, dry weight (Table-1). Plant height is a good index of crop vigour. In general, plant height increased with the advancement of plant age up to harvest. Replacement of NPK with FYM when combined with sulphur had marked effect on the plant height at various growth stages. The plant height was significantly higher with the application of T_{10} (75% NPK+40 kg S ha^{-1} + 10 t FYM ha^{-1}) which were at par with T_9 (75% NPK+20 kg S ha^{-1} + 10 t FYM ha^{-1}). Application of farm yard manures along with other chemical fertilizers and sulphur proves better result. That might be due to the role of FYM in enhancing soil health, quality and biological properties of soil. FYM has synergistic effect and helping in mineralization of applied nitrogen and phosphorus, which might help in enhancing of growth parameters (Lal *et al.*, 1996). Similar result also reported by Jat *et al*. (2012). Similar to plant height, number of branches plant^{-1} increased with the advancement of plant age up to harvest. Replacement of NPK with FYM when combined with sulphur had marked effect on the number of branches at various growth stages. This indicates that NPK requirement of the crop may be replaced by 25% with addition of other nutrient sources for branches of mustard. Our findings corroborate with the findings of Sarma and Debnath (1999) and Aulakh and Pasricha (1997).

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

Treatments	Plant height (cm)	No of branches plant^{-1}	Dry wt. (g)	No of Siliquae plant^{-1}	No of seeds siliquae^{-1}	1000-seed weight (g)
T1 (Control)	135.71	15.57	11.8	211.67	11.63	4.50
T2 (120% NPK)	164.43	20.67	14.2	264.10	12.33	4.62
T3 (120% NPK + 20 kg S ha^{-1})	170.81	25.67	17.87	279.60	13.60	4.57
T4 (120% NPK + 40 kg S ha^{-1})	173.81	27.47	15.23	265.67	13.50	4.46
T5 (100 % NPK)	163.58	23.27	19.67	240.80	15.27	4.64
T6 (100% NPK + 20 kg S ha^{-1})	166.42	23.80	13.92	249.93	13.43	5.61
T7 (100% NPK + 40 kg S ha^{-1})	167.71	23.53	18.47	318.47	13.73	4.96
T8 (75% NPK + 10 t FYM ha^{-1})	165.44	25.47	19.27	375.10	14.77	5.41
T9 (75% NPK +20 kg S ha^{-1} + 10 t FYM ha^{-1})	174.10	24.53	20.60	369.20	15.70	5.46
T10 (75% NPK +40 kg S ha^{-1} + 10 t FYM ha^{-1})	174.63	24.47	21.47	381.40	14.10	5.52

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

YIELD ATTRIBUTES

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

SEED AND STOVER YIELD

The data in table 2 proved that the 75 % NPK with Sulphur and FYM recorded significantly highest seed and stover yield per ha over the other treatment. This might be due to deprive of nutrients former and supply over critical level in later treatment, which increase siliquae plant^{-1}, number of seeds siliquae^{-1} and 1000-seed weight. These results are in close conformity with the findings of Piri and Sharma (2006). The Stover yield was found significantly variable according to the treatments. That might be possible because plants received nutrients from appropriate sources to give their full potential for influencing the harvest index of mustard. It seems that the better utilization efficiency of NPK, S and FYM in response on optimum these nutrients reflected in greater vegetative growth and increase growth enzymatic activity. These results are in close conformity with the findings of Faujdar *et al*. (2008), Neha *et al*. (2014), Kumar et al. (2001). Integration of FYM increased the cost of treatment, therefore, reduced the system net returns as compared to chemical fertilizers, but if we replace the doses of chemical fertilizers with FYM it compensates total cost of inputs.

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

Treatments	Seed Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})	Harvest index (%)	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C ratio
T1 (Control)	812.6	3183.47	20.30	34841.41	10391.41	0.43
T2 (120% NPK)	1273.8	4386.40	22.50	53710.2	24612.2	0.85
T3 (120% NPK + 20 kg S ha^{-1})	1430.9	4982.13	22.30	60416.5	30518.5	1.02
T4 (120% NPK + 40 kg S ha^{-1})	1421.0	5409.33	20.84	60691	29993	0.98
T5 (100 % NPK)	1207.1	4413.60	21.45	51283.1	23095.1	0.82
T6 (100% NPK + 20 kg S ha^{-1})	1356.3	4515.20	23.11	56955.9	27967.9	0.96
T7 (100% NPK + 40 kg S ha^{-1})	1469.6	4912.53	23.11	61744	31956	1.07
T8 (75% NPK + 10 t FYM ha^{-1})	1280.8	4933.07	20.63	54789.21	24546.21	0.81
T9 (75% NPK +20 kg S ha^{-1} + 10 t FYM ha^{-1})	1514.3	5381.33	21.98	64101.1	33058.1	1.06
T10 (75% NPK +40 kg S ha^{-1} + 10 t FYM ha^{-1})	1546.5	5161.60	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			

OIL AND PROTEIN CONTENT

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

It was found that the application of Sulphur and FYM resulted significant increase in protein content. Sulphur being a constituent of S containing amino acids and increased in protein content. Significant increase in protein content may be due to the increase in availability of Sulphur and nitrogen resulted in protein synthesis. These findings are close agreement with Singh et. al., 1998 and Kumar et. al., 2006.

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

Treatments	**Oil content (%)**	**Protein content (%)**
Control	41.76	21.20
120% NPK	43.72	23.36
120% NPK + 20 kg S ha^{-1}	44.04	23.75
120% NPK + 40 kg S ha^{-1}	44.36	23.95
100 % NPK	44.37	21.15
100% NPK + 20 kg S ha^{-1}	43.99	22.53
100% NPK + 40 kg S ha^{-1}	45.30	23.81
75% NPK + 10 t FYM ha^{-1}	45.59	23.53

75% NPK +20 kg S ha^{-1} + 10 t FYM ha^{-1}	45.57	24.08
75% NPK +40 kg S ha^{-1} + 10 t FYM ha^{-1}	45.76	24.28
SE(m)	0.171	0.367
LSD (P=0.05)	0.511	1.098

CONCLUSIONS:

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

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