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Effect of Nitrogen, Phosphorus, Potassium, Sulphur and Zinc on Yield and their Attributing Characterstics of Mustard Crop

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted on Pot culture house of Department of Soil Science and Agricultural Chemistry at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the rabi season 2016-17, In the present experiment 8 treatments T1 (Control), T2 (100% RDF Recommended dose of fertilizer) , T3 (100% RDF+S30), T4 (100% RDF+Zn5), T5 (125% RDF), T6(125% RDF+S30), T7 (125% RDF+Zn5), T8 (150% RDF), were laid out in Randomized Block Design(RBD) with four replications. Mustard variety Pusa Bold was taken for study. The results revealed that the Yield (grain and stover yield) and their attributing characterstics of mustard respond significantly with the different treatment combination. The highest grain (20.11 q/ha) and stover yield (43.13 q/ha) was obtained in T7 (125% RDF+Zn5) . The treatment T7 cause 32.72 % increase in mustard grain yield and 14.22% increase in stover yield over control.. The treatment combination T7 (125% RDF+Zn5) gave the best result in terms of yield and their attributing characterstics.

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1. INTRODUCTION

India is the fourth largest oilseed economy in the world. Rapeseed-mustard contributes 28.6% in the total oilseeds production among the seven edible oilseeds cultivated in India and ranks second after groundnut sharing 27.8% in the India's oilseed economy [1]. Indian mustard (*Brassica juncea* L.) is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat and some non-traditional areas of South India including Karnataka, Tamil Nadu, and Andhra Pradesh. Indian mustard (*Brassica juncea*L.) commonly known as raya,rai or lahi is an important oilseed crop among the Brassica group of oilseed in India. Rapeseed-mustard is an important group of edible oil seed crops and contributes about 26.1% of the total oil seed production and contributes about 85% of the total rapeseed– mustard produced in India (Meena *et al.,* 2011). The first position in area and second position in Production after China (Anonymous, 2009).In India 2016-17 the production of oilseed crops was 32.10 million tones.

Quality of the oil in the rapeseeds and mustard possess a adequate amount of erucic acid 40-60% together with Linolinic up to 4.5 to 13%.The oleic acid and linoleic acid which have a higher nutritive value together constituent only about 25-30%.It is desirable to increase the quality of oleic acid and linoleic acid by reducing the linolinic and erucic acid , a lower proportion of erucic acid will make the oil more palatable, nutritive, besides reducing metabolic disorders. The oil content in mustard about 35-40% and protein content ranges from 25-30%.But the presence of toxic glucosinolate in mustard render it unavailable as a source of human protein and is present used as a manures and a animal feed. Although it has been know the effect nitrogen, phosphorus, potassium, sulphur and zinc in mustard production is beneficial, yet pieces information regarding the effect of these nutrients on production, crop quality and other nutrients effects in plants are partically lacking. Therefore, to gain the information regards various aspects pertaining its quality, yield and other nutrients effect is imperative in the proper use of nitrogen, phosphorus, potassium, sulphur and zinc.

Katiyar et al. [2] reported that application of sulphur 90 % DP @ 25 kg ha-1 basal had significant influence on yield attributes and grain yield of mustard. Maximum value of seeds per pod, thousand grain weight and grain yield were recorded with dual application basal along with 80% WP @ 1.25 kg ha-1 foliar sprayed at 75 DAS closely followed by application of sulphur as basal + 80% WP @ 5 kg ha-1 applied with urea broadcasting at 45 DAS and minimum value under farmers practice.

Kumar and Trivedi [3] reported that the highest seed and straw yields were observed with use of ammonium sulphate which was significantly higher over othersources. The maximum seed and straw yields were recorded with the application of ammonium sulphate followed by gypsum, single super phosphate and pyrite.

Kumar et al. [4] reported thatthe sources of sulphur (gypsum, bentonite S, pyrite) did not influence significantly the yield attributes and yield of Indian mustard (Brassica juncea L.) in the experiment by Kumar et al. (2011).

Kutuk et al. [5] also suggested that the application of Zn has become necessary for improved crop yields.

Mandal and Sinha [6] recommended application of ZnSO4 at the rate of 20 kg ha-1 for oilseeds including mustard.

Sharma et al. [7] also observed that mustard seed yield increased significantly by 33% to 141% over control with the application of sulphur. Significant improvement in the number of siliqua/ plant, test weight, seed yield and stover yield was recorded with sulphur fertilization as compared to control. Higher yield with increased application of sulphur also attributed protein and enzyme synthesis as it is a constituent of sulphur containing amino acids namely methonine, cysteine and cystine.

Singh et al. [1] reported that plant height, number of branches/plant, number of seeds/siliqua and length of siliqua were not influenced significantly due to various levels of nitrogen, phosphorus and potassium except number of primary branches/plant and number of siliquae/plant which were significantly higher with the application of 80 kg N/ha followed by 100 kg N/ha . While, number of seeds/siliqua was recorded higher under application of 100 kg N/ha and it's remained statistically at par with application of 80 kg N/ha. The 1000-seed weight remained unaffected due to various levels of NPK.

Tripathi *et al.,* (2011) reported that the interaction effect of different levels of NPK and Sulphur the important plant yield attributes parameters of mustard crop. Higher yield response in comparison of NPK and Sulphur alone was recorded with balanced application of NPK and Sulphur. The maximum number of siliqua plant-1 was recorded.

2. MATERIALS AND METHODS

The experiment was conducted on mustard crop during *rabi* season of 2016- 17 under natural condition at Pot culture house of Department of Soil Science and Agricultural Chemistry at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The soil of the experimental field was alluvial in origin. Soil sample from 15cm depths were initially drawn from randomly selected parts of the field before sowing. The quantity of soil sample was reduced to a 500 gm through quartering technique. The soil sample was then subjected to mechanical and chemical analysis in order to determine the textural class and fertility status the soils were sampled to a depth of 0-30 cm of the soil, air-dried and sieved (2 mm) for soil analyses.Some physical and chemical properties of soils are given in Table 1.

Mustard variety Pusa Bold was taken for study. In the present experiment 8 treatments T_1 (Control), T_2 (100% RDF) , T_3 (100% RDF+S_{30}), T_4 (100% RDF+Zn_5), T_5 (125% RDF), T_6(125% RDF+S_{30}), T_7 (125% RDF+Zn_5), T_8 (150% RDF), f were laid out in Randomized Block Design(RBD) with four replications having plot size 2 x 2 meter square. Doses of fertilizers are applied @ 120 Kg N, 40 Kg P_2O_5, 40 Kg K_2O/ha 30 Kg S/ha, 5 Kg Zn/ha through Urea, D.A.P and Murate of Potash, Elemental sulphur, Zinc oxide. Sowing is done @ 5 kg seed ha^{-1} Mustard variety Pusa Bold was used and sown on 30 October 2016. Row to row and plant to plant distance remain 45 and 20 respectively. Seed were sown about 1-2 cm depth.

Field Preparation: The experimental field was ploughed once with soil turning plough fallowed by two cross harrowing. After each operation, planking was done to level the field and to obtain the fine tilth. Finally layout was done and plots were demarked with small sticks and rope with the help of mannual labour in each block.

Application of fertilizers: The crop was fertilized as per treatment. The recommended dose of nutrient i.e. N, P, and K was applied @ 120 : 40 : 40 kg ha^{-1} respectively.

Time and method of fertilizer: Half does N_2 and total phosphorus, potash, zinc and sulphur were applied as basal dressing. Remaining dose of nitrogen was applied through top dressing after 1st Irrigation.

Seed Treatment: To ensure the seeds free from seed borne diseases, seeds were treated with thiram 75% WDP (1.5 g/kg of seed).

Table 1. Some properties of the < 2mm fraction of the top 30 cm of soil used for the site

S.No.	Particulars	Values
1.	Sand (%)	39.00
2.	Silt (%)	40.00
3.	Clay (%)	21.00
4.	Textural Class	Loam
5.	pH (1:2.5)	8.1
6.	EC (1:2.5) (ds/m at 25^0C)	0.34
7.	Organic Carbon (%)	0.40
8.	Available Nitrogen (kg/ha)	185.00
9.	Available Phosphorus (kg/ha)	9.80
10.	Available Potassium (kg/ha)	120.00
11.	Available Sulphur (kg/ha)	12.54
12.	Available Zinc (ppm)	0.40
13.	Particle Density (Mg/m^3)	2.54
14.	Bulk Density (Mg/m^3)	1.30
15.	Pore Space (%)	46.0

Intercultural operations: Weeding and hoeing were done with khurpi and hand hoe after germination.

Thinning: To maintain proper distance with in row and plant population by thinning of the plants were carried out after 25 days of sowing.

Irrigation: Tube-well was the source of irrigation. Irrigation was provided in the crop as and when required.

Harvesting: The crop was harvested at proper stage of maturity as determined by visual observations.

Threshing: Bundles were dried and weighed, individually of each plot then beaten with wooden sticks and seeds were separated by winnowing.

Yield: The production of each plot collected separately and packed in bags carefully avoiding contamination. The grains of each bag were than weighed and recorded in kg/net plot and there after computed as q/ha. Similarly straw yield was also recorded.

2.1 Soil Analysis

Mechanical Separates:-Soil separates analyzed by International pipette method as described by the Piper (1966).

pH:- pH of the soil determined by using soil water suspension (1:2.5) with the help of digital pH meter.

EC:- EC also determined using soil water suspension (1:2.5) with help of conductivity meter (Jackson, 1967).

Organic Carbon:- Organic Carbon was determined by Walkley and Black's rapid titration method as described by Jackson (1967).

Available Nitrogen:- It was determined by Alkaline Potassium Permagnate Method described by Subbiah and Asija(1956).
Available Phosphorus:- It is determined by Olsen's method using 0.5 M NaHCO3 (Olsen et al. 1954).

Available Potassium:- Potassium is determined by using Neutral Normal Ammonium Acetate (pH 7.0) by Flame Photometer.

Available Sulphur:- Available Sulphur was determined by turbidimetric method (Chesnin and Yien,1950) after extraction with 0.15%$CaCl_2$ solution.

Available Zinc:- Available Zn is determined by Atomic Absorption Spectrophotometer with the help of DTPA extractant **(**Lindsey and Norvell, 1978).

2.2 Yield of Crop

Grain Yield:-The clean and dried grains from each plot weighed with the help of electronic balance in kg/ha and converted into q/ha.

Stover Yield:- Stalk yield can be obtained by subtracting grain yield from the biological yield.

Observations recorded: The observations were recorded as per the procedure described below. For this purpose 5 plants were selected randomly in each net plot and were tagged with a level for recording various observations on growth and yield parameters.

Biometric observation: Biometric observation such as Number of siliqua plant-^{1}, Number of seeds siliqua^{-1}, 1000-seed weight (g), Plant height (cm), Number of primary branches plant-1, Number of secondary branches plant^{-1}, were recorded treatment wise grain and stover yields were recorded per plot and converted into quantal ha^{-1}.

The data on various characters studied during the course of investigation were statistically analyzed for randomized block design. Wherever treatment differences were significant ("F" test), critical differences were worked out at five per cent probability level. The data obtained during the study were subjected to statistical analysis using the methods advocated by Chandel (1990).

3. RESULTS

Effects of different treatments on yield & yield attributing characterstics these are specified that:

3.1 Seed Yield (q ha^{-1})

The data pertaining to seed yield (q ha-1) as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc are given in Table 2. The analysis of variance of seed yield (q ha^{-1}) The perusal of data in Table 1 clearly reveals that the seed yield (q ha^{-1}) was significantly affected by different levels of nitrogen, phosphorus, potassium, sulphur and zinc. The application of mineral nutrients at increasing level also laid out significantly influence on seed yield (q ha^{-1})during the year and in pooled mean (Table 2). Application of mineral nutrients at level 125 % RDF of N,P & K +5kg/ha Zn (T_7) resulted in significantly maximum seed yield q ha^{-1} (20.11) during the year 2016-17. The corresponding increase was recorded as 48.63 % higher over control during the year 2016-17 of mean values that is T_7 have superior. The other treatments have pertaining to seed yield (q ha^{-1}) as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance result the values are T_8,T_4,T_6,T_3,T_5,T_2& T_1 (19.21,18.78,17.23,16.93,16.90,15.80 & 13.53) seed yield (q ha^{-1}) ,respectively and T_1 have lowest seed yield (q ha^{-1}).

3.2 Stover Yield (q ha^{-1})

The data pertaining to stover yield (q ha^{-1}) as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc are given in Table 2. The analysis of variance of stover yield (q ha^{-1}) . The perusal of data in Table 1 clearly reveals that the stover yield (qha^{-1}) was significantly affected by different levels of nitrogen, phosphorus, potassium, sulphur and zinc to influence the stover yield significantly. Show significance result the values are T_8,T_4,T_6,T_3,T_5,T_2& T_1 (41.23,40.93,38.97,38.83, 38.53,38.23 & 37.07) stover yield (q ha^{-1}) ,respectively and T_1 have lowest stover yield (q ha^{-1}).

3.3 Number of Siliqua plant-^{1}

The data pertaining to number of siliqua (plant-^{1}) as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc are given in Table 3. The analysis of variance of number of siliquae (plant-^{1}). The perusal of data presented in Table 3 clearly reveals that the number of siliqua (plant-^{1}) was significantly influenced by different levels of nitrogen, phosphorus and potassium, sulphur and zinc.The application of N,P,K,S & Zn nutrients at increasing level also significantly increased the number of siliquae per plant during the year 2016-17 in mean values. The application of 125 % RDF of N,P & K +5kg/ha Zn (T_7) registered significantly maximum number of siliqua per plant (252.50) during the year 2016-17 and in mean values and the corresponding increases was 10.34per cent higher over control that is T $_7$ have superior. The other treatments have pertaining to number of siliqua (plant-^{1}) as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance data T_8,T_4,T_6,T_3,T_5,T_2& T_1(251.75,25O.25, 149.50,248.25, 247.25 & 244.25 No. of siliqua per plant) ,respectively T_1 have lowest No. of siliqua per plant.

3.4 Number of Seeds per Siliqua

The data pertaining to number of seeds siliqua^{-1} as influenced by different levels of N, P, K, S & Zn are presented in Table 3. The analysis of variance of number of seeds (siliqua^{-1}).The application of mineral nutrients at increasing level also laid out significantly influence on number of seeds per siliqua during the year and in pooled mean . Application of mineral nutrients at level 125 % RDF of N,P, & K +5kg/ha Zn (T_7) resulted in significantly maximum number of seeds per siliqua (13.25) during the year 2016-17. The corresponding increase was recorded as 26.19 % higher over control during the year 2016-17 of mean values that is T $_7$ have superior. The other treatments have pertaining to number of seed/siliqua as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance result T_8,T_4,T_6,T_3,T_5,T_2& T_1 (12.75,12.50,12.25,11.50,11.25,11.00 &10.50) No. of seed/siliqua) ,respectively T_1 have lowest No. of seed/siliqua .

3.5 1000-Seed Weight (g)

The data pertaining to 1000-seed weight (g) as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and Zinc are given in Table 3. The analysis of variance of 1000-seed weight (g). The perusal of data in Table 3 clearly reveals that the 1000-seed weight (g) was significantly influenced by different levels of nitrogen, phosphorus, potassium sulphur and Zinc .The conjunctive use of mineral nutrients have also registered a significant increase in test weight of seeds (4.66g) and the per cent increase in test weight was recorded as 8.37 % higher with treatment application 125 % RDF ofN,P,K+5 Kg/ha Zn (T_7), over T_1 (control), respectively during the year 2016-17 and pooled analysis that is T $_7$ have superior. The other treatments have pertaining to test wieght as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance result values are T_8,T_4,T_6,T_3,T_5,T_2& T_1 (4.64,4.63,4.61,4.56,4.53,4.51 & 4.30 No. of seed/siliqua) ,respectively T_1 have lowest seed weight .

Table 2. Effects of different treatments on seed yield & stover yield

Sr.No.	Treatments	Symbol	Seed Yield q/ha	Stover Yield q/ha
1	Control	T_1	13.53	37.07
2	NPK(100%)RDF	T_2	15.80	38.23
3	NPK(100%)RDF+S_{30}	T_3	16.93	38.83
4	NPK(100%)RDF+Zn_5	T_4	18.78	40.93
5	NPK(125%)RDF	T_5	16.90	38.53
6	NPK(125%)RDF+S_{30}	T_6	17.23	38.97
7	NPK(125%)RDF+Zn5	T_7	20.11	43.13
8	NPK(150%)RDF	T_8	19.21	41.23
	MEAN		17.31	39.61
	SE(d)		0.339	0.292
	CD(5%)		0.709	0.611

Table 3. Effects of different treatments on yield attributing characters

Sr.No.	Treatments	Symbol	No.of siliqua/plant	No.of seed/siliqua	Test wt. (gm)
1	Control	T_1	244.25	10.50	4.30
2	NPK(100%)RDF	T_2	246.75	11.00	4.51
3	NPK(100%)RDF+S_{30}	T_3	248.25	11.50	4.56
4	NPK(100%)RDF+Zn_5	T_4	250.25	12.50	4.63
5	NPK(125%)RDF	T_5	247.25	11.25	4.53
6	NPK(125%)RDF+S_{30}	T_6	249.50	12.25	4.61
7	NPK(125%)RDF+Zn5	T_7	252.50	13.25	4.66
8	NPK(150%)RDF	T_8	251.75	12.75	4.64
	MEAN		**248.81**	**11.87**	**4.56**
	SE (d)		**0.393**	**0.558**	**0.031**
	CD (5%)		**0.823**	**1.169**	**0.064**

Table 4. Effects of different treatments on yield attributing characters

Sr.No.	Treatments	Symbol	Plant Height (cm)	No. of Primary branches	No. of secondary branches
1	Control	T_1	143.50	4.00	10.25
2	NPK(100%)RDF	T_2	144.75	4.50	10.75
3	NPK(100%)RDF+S_{30}	T_3	146.50	5.00	11.50
4	NPK(100%)RDF+Zn_5	T_4	147.25	5.75	12.25
5	NPK(125%)RDF	T_5	145.75	4.75	11.25
6	NPK(125%)RDF+S_{30}	T_6	146.75	5.25	11.75
7	NPK(125%)RDF+Zn5	T_7	148.25	6.75	12.75
8	NPK(150%)RDF	T_8	147.75	6.25	12.50
	MEAN		**146.31**	**5.28**	**11.62**
	SE(d)		**0.530**	**0.619**	**0.357**
	CD(5%)		**1.110**	**0.619**	**0.747**

3.6 Plant Height (cm)

The data pertaining to plant height (cm) at 30, 60, 60, 90, 120 DAS and at maturity as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc are presented in Table 3 (mean values).The analysis of variance of plant height (cm) at 30, 60, 90, 120 DAS and at maturity. Irrespective of different treatments, it is evident from the data (Table 3) that plant height increased with the increases in the age of the plant and reached the maximum at maturity. result values are T_8,T_4,T_6,T_3,T_5,T_2& T_1 (147.75,147.25,146.75,146.50,145.75,144.75 & 143.50 height of plant (cm) ,respectively T_1 have lowest height of plant(cm).

3.7 Number of Primary Branches Plant-[1]

The data pertaining to number of primary branches plant^{-1} at 60, 80, 100 DAS and at maturity as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc are presented in Table 3. The analysis of variance of number of primary branches (plant^{-1}) at 60, 80, 100 DAS and at maturity. The perusal of data indicated that different levels of nitrogen, phosphorus, potassium, sulphur and zinc were significantly influenced the number of primary branches (plant-1) at 60, 80, 100 DAS and at maturity. The application of mineral nutrients at increasing level also laid out significantly influence on number of primary branches during the year and in pooled mean (Table 3). Application of mineral nutrients at level 125 % RDF of N,P, & K +5kg/ha Zn (T_7) resulted in significantly maximum number of primary branches (6.75) during the year 2016-17. The corresponding increase was recorded as 68.75 % higher over control during the year 2016-17 of mean values that is T_7 is superior. The other treatments have pertaining to number of primary branches plant^{-1} as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance result the values are T_8,T_4,T_6,T_3,T_5,T_2& T_1 (6.25,5.75,5.25, 5.00,4.75,4.50 & 4.00 number of primary branches plant^{-1} ,respectively T_1 have lowest number of primary branches plant^{-1}.

3.8 Number of Secondary Branches Plant^{-1}

The data pertaining to number of secondary branches plant^{-1} at 60, 80, 100 DAS and at maturity as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc are given in Table 3. The analysis of variance of number of secondary branches (plant^{-1}) at 60, 80, 100 DAS and at maturity. The perusal of data indicated that different levels of nitrogen, Phosphorus, potassium, sulphur and zinc were significantly influenced the number of secondary branches (plant^{-1}) at 60, 80, 100 DAS and at maturity. The application of mineral nutrients at increasing level also laid out significantly influence on number of secondary branches (plant^{-1})during the year and in pooled mean (Table 3). Application of mineral nutrients at level 125 % RDF of N,P, &K +5kg/ha Zn (T_7) resulted in significantly maximum number of secondary branches (plant^{-1}) (12.75) during the year 2016-17. The corresponding increase was recorded as 24.39 % higher over control during the year 2016-17 of mean values that is T_7 have superior. The other treatments have pertaining to number of secondary branches plant^{-1} as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance result the values are T_8,T_4,T_6,T_3,T_5,T_2&$T_{1=}$(12.50,12.25,11.75,11.50,11 .25,10.75& 10.25)number of secondary branches plant^{-1} ,respectively T_1 have lowest number of secondary branches plant^{-1}.

4. DISCUSSION

4.1 Effect of N, P & K on Yield and Yield Attributing Characters

The number of siliqua plant^{-1}, number of seeds siliqua^{-1}, test weight, plant height, no. of primary branches, no. of secondary branches, seed yield (q ha^{-1}) and stover yield (q ha^{-1}) increased significantly by application of higher dose of N,P & K 125 % of RDF+Zn 5 kg ha^{-1} over the control (Tables 1,2 & 3). It might be due to improved availability of NPK through urea, DAP & MOP. The favourable effect of higher dose of NPK on sink component could be attributed to better development of the plants in terms of plant height and dry biomass production leading to increased bearing capacity due to optimum growth on account of increased in NPK dose. The application of 125% NPK of RDF, by preventing flower and siliqua abscission, increasing the number of siliqua per unit area and affecting 1000 seed weight led to more seed yield. Higher seed yield with increasing rate of NPK was also reported by Siadat et al. (2010), Keivanrad and Zandi (2012) and Keivanrad and Zandi (2014).

4.2 Effect of Sulphur on Yield

Shows the interaction effect of different levels of NPK and Sulphur in the important yield parameters of mustard crop(Tables 1,2 & 3) Increase in plant height due to increasing of NPK and Sulphur may be due to adequate nutrients which are turns help in vigorous vegetative growth of plants and subsequently increase the plant height through cell elongation cell division photosynthesis and turbidity of plant cell. The maximum height recorded as 148.25 cm, 120 DAS in treatment T_7. Similar results have also been recorded by Tripathi *et al.,* (2011).

(Tables 1,2 & 3) shows the interaction effect of different levels of NPK and Sulphur the important plant yield attributes parameters of mustard crop. Higher yield response in comparison of NPK and Sulphur alone was recorded with balanced application of NPK and Sulphur. The maximum number of siliqua plant-1 was recorded as 252.50 in treatment T_7 and minimum number of siliqua plant^{-1} was recorded as 244.25 in treatment T_1 and were found to be significant. The application of mineral nutrients at increasing level also laid out significantly influence on plant height during the year and in pooled mean (Table 2). Application of mineral nutrients at level 125 % RDF of N,P, & K +5kg/ha Zn (T_7) resulted in significantly maximum height of plant (148.25) during the year 2016-17. The corresponding increase was recorded as 03.31 % higher over control during the year 2016-17 of mean values that is T_7 is superior.

The other treatments have pertaining to height of plant as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance result values are T_8,T_4,T_6,T_3,T_5,T_2& T_1 (147.75,147.25,146.75,146.50,145.75,144.75 & 143.50 height of plant(cm),respectively T_1 have lowest height of plant(cm).

4.3 Effect of Zn on Yield

(Tables 1,2 & 3) The study showed that Zn level resulted to increase the plant height, branches per plant, that took less days to reach at flowering stage, siliqua per plant, seeds per siliqua, test weight of seeds per plant, seed yield and oil percent level. The results further are in agreed with the soils have become deficient of micronutrients, particularly Zinc deficiency has resulted significant reduction in crop yields (Rashid *et al.,* 1993; [8]. These results are partially supported by Maqsood *et al.,* (2009) who reported that the seed yield can be improved by addition of Zn fertilization;

Moreover, the variety pusa bold may preferably grow for obtaining higher seed and oil yields in mustard so far. In a similar investigation, the study of Mandal and Sinha, (2004) examined the effect of Zn and B application in addition to NPK fertilizers on production and yield of Indian mustard. Plant height, number of branches per plant, number of siliqua per plant, number of seeds per siliquae, 1000-seed weight with 20 kg ha^{-1} ZnSO4. The results indicated that the seed yield kg ha-1 was highest under NPK125% of RDF 5 kg Zn ha-1 in T_7 .The maximum yield of seed were (20.11 q ha^{-1}) and stover yield(43.13 q ha^{-1}) in treatment 7 show significant effects.

The application of N, P, K, S & Zn nutrients at increasing levels also significantly increased the stover yield (q ha^{-1})during the year 2016-17 in mean values (Table 3). The application of 125 % RDF of N,P&K +5kg/ha Zn (T_7) registered significantly maximum stover yield (q ha^{-1}) (43.13) during the year 2016 17 and in mean values and the corresponding increases was 16.35 per cent higher over T_1 during the years 2016-17 that is T_7 have superior.

The other treatments have pertaining to stover yield (q ha^{-1}) as influenced by different levels of nitrogen, phosphorus, potassium, sulphur and zinc show significance result the values are T_8,T_4,T_6,T_3,T_5,T_2& T_1 (41.23,40.93,38.97,38.83, 38.53,38.23& 37.07) stover yield (q ha^{-1}) ,respectively and T_1 have lowest stover yield (q ha^{-1}).

5. CONCLUSIONS

From the results of one-year field investigation during *rabi* 2016-17, it could be concluded that among different NPK levels, application of NPK @ 125% of RDF + 5kg ha^{-1} Zinc resulted into significantly higher seed yield (20.11 q ha^{-1}) & stover yield (43.13 q ha^{-1}), oil yield (869.75 kg ha^{-1}) of Indian mustard variety Pusa bold as compared to application of NPK 100% RDF. Application of NPK @ 125% RDF + 5 kg ha^{-1} Zinc increases 27.28 % & 12.82 % seed & stover yield, respectively over NPK 100% RDF. Among different levels of NPK 125% of RDF + 30 kg ha^{-1} sulphur, applied resulted into significantly higher seed yield (17.23 q ha^{-1}), Stover yield (38.97 q ha^{-1}), oil yield (719.35 kg ha $^{-1}$) of Indian mustard var. pusa bold as compared to application of NPK 100% of RDF. Application of NPK 125% of RDF + 30 kg ha^{-1} sulphur resulted higher seed yield (9.05%) & Stover yield(1.95%) over NPK 100% RDF.

The one year experiment based on pooled results, it could be concluded that there is a need for prescribing suitable balanced fertilization to mustard crop i.e. application of mineral nutrients 125 % RDF of NPK+5 kg ha^{-1} Zinc or 30 kg ha^{-1}sulphur found to be most suitable to get maximum crop productivity and improved soil quality in Sulphur & Zinc deficient soil.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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