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RESPONSE OF PHOSPHORUS AND MOLYBDENUM ON YIELD AND QUALITY ATTRIBUTING CHARACTERS OF INDIAN MUSTARD (*BRASSICA JUNCEA* L. CZERN & COSS)

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ABSTRACT
The oilseeds scenario in India has undergone a significant change in recent years. Present study suggests that increasing doses of P (upto 60kg/ha) and Mo (upto 4kg/ha) directly influence the yield and yield attributing parameters of mustard. Significant correlation was observed among number of siliquae per plant, Primary/ Secondary/ Tertiary branches, No. of siliquae/ No. of seed per siliqua, yield and oil content by different doses of P and Mo. P and Mo levels did not affect Siliqua length, Protein content and other biochemical characters significantly. Among fatty acids saturated fatty acids varies between 3.11-4.10%, whereas, unsaturated fatty acids between 4.32-48.45%.

INTRODUCTION

The importance of oilseeds in Indian economy is well documented and there is need to raise the oilseed production to bridge the large gap between the demand and supply of edible oils. Rapeseed-mustard shares about 28 per cent of total oilseed production in India, with area of 6.32m ha and production of 6.12m. It is only second to groundnut among oilseeds. Commercially rapeseed-mustard are obtained from the genus *Brassica* belonging to the family cruciferae. Brassica crops are destined to play an ever-increasing role in the supply of the world's food, feed and industrial needs in the next century. Rapeseed-mustard seed is mainly used for extraction of oil. Seed meal obtained after oil extraction from the seed is used as an animal feed. It is a rich source of good quality proteins and can be utilized for production of value-added products like protein concentrate, baby food and biscuits after some processing. Presently, it is largely been consumed as animal feed and also being exported to some extent (Chauhan and Kumar, 2011). There may be a number of factors responsible for low yield of mustard in India but poor soil fertility status and sub optimal use of fertilizer nutrients, particularly, nitrogen and phosphorus appears to be most important (Premi and Kumar, 2004; Kumar, 1999). Phosphorous plays a vital role as a structural component of cell constituent and metabolically active compounds *i.e.* chloroplasts, mitochondria, phytin, nucleic acid, protein, flavin nucleotides and several enzymes. It also plays a crucial role in growth and development of roots, tillers and grains, energy transformation and metabolic process of plants (Wang and Tillberg, 1998). Micronutrient helps in photosynthetic activities and proper utilization of nitrogen and phosphorus. In many parts of our country micronutrient like zinc, boron, molybdenum and others have been reported to be deficient. Keeping this in view, the present investigation was carried out to evaluate the effect of P and Mo on yield and quality characters of mustard varieties suitable for Northern Zone of India.

MATERIALS AND METHODS

The present investigation was undertaken using different doses of P(0,30 and 60 Kg/ha) and Mo(0,2 and 4 Kg/ha) at the time of sowing on two mustard varieties (Varuna and Kranti). Agronomic characters (No. of branches, plant height, No. of siliquae per plant etc.) were recorded manually. After ripening, the homogenous ground seed samples from gross produce of each plot were kept in the oven at 70ºC for 5-6h. for removal of moisture. After it, seeds were grinded for oil extraction. The conventional soxhlet technique was used to estimate oil content using hexane (AOAC, 1970**)**. After oil extractions following biochemical parameters were determined:

Iodine value (Hart and Fisher, 1971): The unsaturated fatty acid residues of the glycerides react with iodine, thus the iodine value indicates the degree of unsaturation of the fatty acid residues of the glycerides. 1g of fat sample was taken in a stoppered bottle and 25mL of Wij's solution was added to it. It was mixed properly and allowed to stand for 1h. Blank was

prepared using chloroform. With the 50mL distilled water the stopper and neck of flask was rinsed properly. 10mL of KI solution was added to it. Then it was titrated with standard sodium thiosulphate(y) till pale yellow appears. After that few drops of starch solution was added and titrated till blue colour disappears. The steps were repeated with a blank which did not contain any fat sample(x).

$$\text{Iodine value} = \frac{(x-y) \times 0.01269 \times 100}{\text{Wt. in g of substance}}$$

Refractive index: Refractometer was cleaned with alcohol and ether. A drop of oil was placed on the prism. The prism was closed by the ground glass-half of the instrument. The dispersion screw was adjusted so that no colour line appeared between the dark and illuminated halves. The dark line was adjusted exactly on the wires and the refractive index was read on the scale.

Tryptophan content (Spice and Chamber, 1949): 0.2g homogenized sample was transferred in 100mL conical flask by adding 10mL con. H_2SO_4. The content of conical flask was kept for 12h in dark for incubation. After expiry of period, 1mL distilled water, 1mL p-dimethyl amino benzaldehyde and 0.1mL of sodium nitrate (0.45% in water) were added. The optical density was measured at 620 nm.

Protein content (Bradford method, 1976**)**: A dilution series of BSA in duplicate was prepared by taking 5, 10, 20, 30, 40, 50, 60, 80, 100µL of BSA stock solution (1mg/mL.). After it, Volume in each tube was made up to 3mL with distilled water. Blank and test solutions were prepared in the same way. Then, Bradford dye (3mL) was added to each tube and tubes were incubated in dark for 30 minutes at room temperature. Absorbance was measured at 595 nm.

Methionine content (Horn *et al.,* 1946): 0.5g sample was weighed and transferred to a flask. 20mL 6 N HCl was added in the samples. The material was reflexed for 20 to 24h then transfered into china disk. It was evaporated on water bath with the addition of 1g activated charcoal. Evaporation was continued until the content of china disk become viscous. Warm distilled water was added and filtered through Whatman filter paper No. 1. The filtrate was collected in 25mL volumetric flask and to make up it 25mL. The china disk was washed with little amount of hot water for about 5-6 time. Filtrate was collected in a flask and transferred to a 50mL beaker. 4mL distil water and 2mL of 5 N-NaOH was added. After that, 0.1mL sodium nitroproside and 2mL glycine solution (3%) was also added. At last, 4.0mL metaphosphoric was added to develop the color. The color intensity was measured at 450 nm.

Allylisothiocynate: Allylisothiocynate content was estimated according to AOAC, 1970.

Fatty acid determination: Methyl esters of fatty acids were prepared by the method described by Singh *et al.*, 2006. This elute was then subjected for analyzing fatty acids by Gas Liquid Chromatography in Central Drug Research Institute, Lucknow.

Experimental design, data collection and analysis

Regarding agronomic characters, five competitive plants were randomly selected from each plot. The ripe siliquae were subjected to threshing and drying for further analysis of quality components. The experimental design for testing of mean and interaction effects of fertilizers was split plot design with 3 replicates.

Table 1: Effect of Phosphorus and Molybdenum on agronomical and biochemical characters of Indian mustard

Varieties	Plant height (cm)	Primary branches	Secondary branches	Tertiary branches	No. of siliquae/ plant	Length of siliqua	No. of seed/ siliqua	1000-seed weight	Yield (q/ha)	Oil content	Protein content	Iodine value	Refractive index	Methionine content (g/16g)	Tryptophan content (g/16g)	Allylisothiocynate content (%)
Varuna	156.87	8.48	12.60	1.11	145.94	4.49	11.06	4.46	22.56	39.12	27.56	108.21	1.4640	1.129	0.850	0.329
Kranti	155.78	7.22	11.00	0.88	142.89	4.42	10.19	3.38	17.80	41.23	28.29	105.62	1.4390	1.037	0.902	0.343
CD at 5%	NS	0.52	0.60	0.42	0.20	NS	0.75	0.40	5.62	0.77	NS	NS	NS	NS	NS	NS
Phosphorus																
0 kg/ha	150.92	6.50	10.58	0.25	128.33	4.31	10.25	4.22	22.28	38.54	26.46	103.23	1.4614	0.858	0.721	0.362
30 kg/ha	156.00	7.22	12.00	0.75	139.17	4.49	10.79	4.36	23.67	41.47	27.89	103.46	1.46165	1.043	0.878	0.342
60 kg/ha	162.08	7.98	12.58	1.20	159.67	4.56	11.34	4.43	24.60	41.69	29.41	104.20	1.4637	1.364	1.195	0.322
CD at 5%	NS	0.48	0.49	0.30	0.18	NS	0.53	NS	4.84	0.81	NS	NS	NS	NS	NS	NS
Molybdenum																
0 kg/ha	152.70	6.59	11.20	0.50	137.83	4.34	9.43	4.00	15.60	39.42	27.14	105.7	1.4614	1.037	0.811	0.347
2 kg/ha	156.00	7.60	11.92	1.00	146.33	4.55	9.91	4.20	16.53	40.96	18.16	106.00	1.4621	1.107	0.978	0.344
4 kg/ha	158.29	8.23	12.25	1.17	148.83	4.63	10.12	4.32	17.96	41.32	18.45	106.68	1.1632	1.121	1.006	0.345
CD at 5%	NS	0.50	0.55	0.28	0.11	NS	NS	NS	3.88	1.14	NS	NS	NS	NS	NS	NS

Interaction effect between phosphorus and molybdenum was found to be non-significant

RESULTS AND DISCUSSION

Number of siliquae per plant, primary/ secondary/ tertiary branches per plant, No. of seeds per siliqua, yield and oil content differed significantly by increasing P level up to 60kg/ ha and Mo levels up to 4kg/ha. P and Mo levels did not affected siliqua length, protein content and other biochemical characters significantly (Table 1). A slight increase in plant height was probably due to increased efficiency of metabolism by P and Mo supply and formation of structural carbohydrates (Ghosh and Gulati, 2001). Phosphorus uptake leads to increased net CO_2 fixations with increased rate of photosynthesis and thereby more photosynthates to develop more No. of pods per plants (Badsra and Chaudhary, 2001). No. of seed per siliqua ranged from 9.43 to 11.34, maximum with phosphorus application @ 60kg/ha and minimum without application of molybdenum. Phosphorus leads to synthesis and deposition of seeds reserves (starch, lipid, protein and phytin) that ultimately produce higher No. of seeds per siliqua (Jat *et al.,* 2000). Variety Varuna was found to be superior with respect to yield (22.56q/ha) and yield attributing characters (Table 1). Phosphorus application significantly increased the number of siliquae/plant (Patel and Shelker, 1998; Premi and Kumar, 2004). The improvement in crop growth increased the yield attributes and thereby the seed yield of mustard. This could further be supported by the positive and significant correlation between yield attributes and yield (Rao *et al.,* 2006*)*. Biochemical parameters did not differed significantly except oil content (Table 1). Oil content was found to be maximum (41.69 per cent) with phosphorus application @ 60 kg/ha and minimum (38.54 per cent) without phosphorus. A slight increase in protein content may be due to increased synthesis of pre-existing as well as new set of proteins by increasing doses of phosphorus (Kundu and Dhaka, 1996).

Ideally the vegetable oil should have low saturation and low polyunsaturation *i*.e. be high in monounsaturated fatty acid, give high oxidation stability (Gunstone, 2004). Among all fatty acids erucic acid was found to be maximum (48.45%) without application of phosphorus (Chauhan and Kumar, 2011; Kaushik and Agnihotri, 2000), Whereas, palmitic acid was found to be minimum (3.11%) in case of phosphorus @ 60 kg/ha. Variety Kranti differed by Varuna for erucic acid content at 5% level of significance (Table 2). Mean values of palmitic,

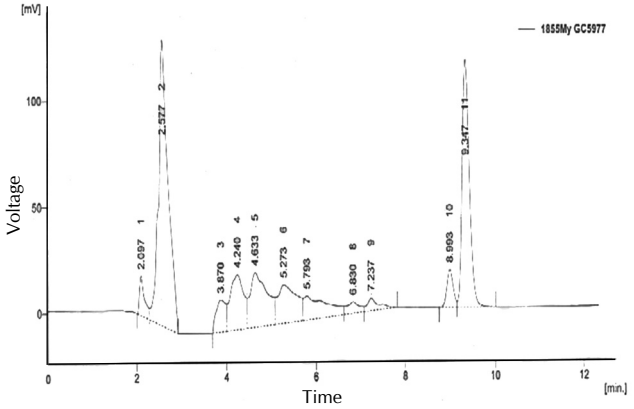

Figure 1: Fatty acid profiling of Varuna by GLC

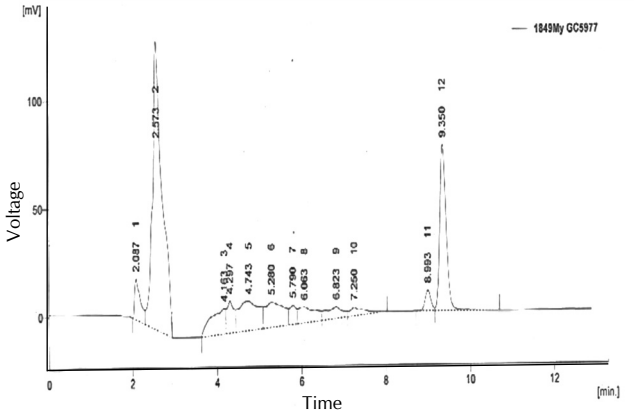

Figure 2: Fatty acid profiling of Kranti by GLC

oleic, linoleic, linolenic, eicosenoic and erucic acid from 3.41-4.10%, 12.12-13.46%, 13.80-15.11%, 13.41-16.63%, 5.38-6.45% and 47.02-48.45% respectively (Table 2; Figs. 1 and 2). Similar findings were reported by Chauhan and Kumar, 2011; Kaushik and Agnihotri, 2000.

The present investigation confirmed that neither Varuna nor Kranti had the internationally accepted quality norms of low erucic acid (< 2%), low linolenic acid (<3%), high oleic acid (around 60 %), high ω-6 to ω-3 fatty acid ratio (5-10) and low glucosinolates (< 30μmoles/g defatted seed meal). But they exhibited very low SFA (Chauhan and Kumar, 2011). It is also confirmed that the considerable amount of genetic variability

Table 2: Effect of phosphorus and molybdenum on fatty acid composition of Indian mustard

Treatment	Palmitic acid	Oleic acid	Linoleic acid	Lenoleinic acid	Eicosenoic acid	Erucic acid	Unidentified acid
Varieties							
Varuna	3.98	13.46	15.11	13.54	6.30	47.29	0.32
Kranti	3.82	13.21	14.97	13.41	6.45	48.00	0.14
Phosphorus							
0 kg/ha	4.10	12.70	14.00	15.00	5.44	48.45	0.31
30 kg/ha	4.00	12.12	14.73	15.25	5.40	48.22	0.28
60 kg/ha	3.11	12.30	13.80	16.63	5.38	48.19	0.20
Molybdenum							
0 kg/ha	4.02	13.25	14.21	14.33	5.88	48.23	0.18
2 kg/ha	3.96	13.21	14.65	15.68	4.84	47.72	0.21
4 kg/ha	3.93	13.33	14.90	16.21	4.32	47.02	0.30

Interaction effect between phosphorus and molybdenum was found to be non-significant

exists in Indian mustard with respect to oil content and oil quality parameters. Comparably Varuna was found to be more efficient in terms of phosphorus and molybdenum application as compared to Kranti, whereas, higher erucic acid content in Kranti make it more suitable for industrial purpose.

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