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EFFECT OF NITROGEN AND PHOSPHORUS ON GROWTH, NUTRIENT CONTENT, SEED YIELD AND QUALITY OF MUSTARD

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SUMMARY

A pot experiment was conducted to study the effect of three levels of nitrogen and phosphorus combinations, i.e. N_{60} P_{30} kg ha^{-1}, N_{80} P_{40} kg ha^{-1} and N_{100} P_{50} kg ha^{-1} on growth, yield and quality of two cultivars of mustard (*Brassica juncea*). The data revealed that cultivar Pusa Bold gave higher plant height, leaf number, leaf area, number primary branches and plant dry weight than Kranti. Application of higher dose of NP fertilizers, i.e. N_{100} P_{50} kg ha^{-1} proved significantly better in improving all these parameters. Higher fertilizer dose also resulted in a significant increase in number of siliqua $plant^{-1}$, length of siliqua and number of seeds $siliqua^{-1}$, which consequently resulted in a marked increase in harvest index and seed yield of both the cultivars. N_{100} P_{50} kg ha^{-1} also resulted in an over all increase in leaf N, P and K contents and seed protein content. Oil content was found to be decreased with increased dose of NP fertilizers, however, extent of decrease in seed oil content was lower than increase in seed yield and thus total edible oil production was still higher with higher fertilizer dose as compared to the normal recommended dose.

***Key words*: Growth, mustard, nitrogen, phosphorus, quality, yield**

INTRODUCTION

The production of oilseeds require more energy than cereals and pulses, but on the contrary they are generally grown on residual soil moisture and poor soil fertility. The most wide spread deficiencies in Indian soils from oilseed production point of view are those of nitrogen and phosphorus, followed by those of sulphur, zinc and potassium (Tandon 1993). Mustard requires a liberal application of nitrogen for sustained productivity on poorly nourished soils (Antil *et al*. 1986). Phosphorus fertilization also plays an important role in crop growth and energy transformation, which is essential in this oilseed crop. Nitrogen and phosphorus, being important constituents of nucleic acids, proteins and other important bio-molecules, play a vital role in plant growth and development. Application of fertilizers was found to be effective in improving the plant growth, nutrient uptake and seed quality of various oilseed crops (Deshmukh *et al*. 1993, Jadhav and Narkhede 1980, Khokhani *et al*. 1993). However, little information is available with regard to N and P fertilizers in mustard. The present investigation was therefore, carried out to study the effect of different levels of nitrogen and phosphorus on growth, nutrient uptake, yield and quality of mustard.

MATERIALS AND METHODS

The present investigation was carried out in cemented pots carrying 8 kg of air-dried soil following

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the factorial concept of CRD at the Screen House of the Department of Plant Physiology, IGAU, Raipur (CG) during the *Rabi* season of 2001 and 2002. Healthy and uniform seeds of improved mustard (*Brassica juncea*) cultivars namely Pusa Bold and Kranti were sown in the pots. Seeds were surface sterilized by captan 75% @ 2 g kg^{-1} of seed. Two plants in each pot were allowed to grow. Three combinations of nitrogen and phosphorus, i.e. N_{60} P_{40} kg ha^{-1} (25% below the normal recommended dose), and N_{80} P_{40} kg ha^{-1} (normal recommendation) and N_{100} P_{50} kg ha^{-1} (25% above normal recommended dose) were applied in 18 replications. Full dose of phosphorus and half dose of nitrogen were given as basal dose, whereas, remaining dose of nitrogen was top-dressed at 30 DAS. The plants were watered normally. Observations on plant height, number leaves, leaf area, number of primary branches and dry matter production were recorded at vegetative (30 DAS), flowering (60 DAS), siliqua development (90 DAS) and maturity stages. Plants were also analyzed for number of siliqua, length of siliqua, number of seeds, 1000-seed weight, harvest index and seed yield. The leaf nitrogen, phosphorus and potassium contents were determined at flowering and siliqua development stages by micro Kjeldahl (Yoshida *et al.* 1972), tri acid (Jackson 1973) and flame photometer respectively. Seed oil content was estimated by Soxhlet's method (Sankaram 1965) and protein content was estimated by the method of Jackson (1967).

RESULTS AND DISCUSSION

Pusa Bold and Kranti differed significantly in their growth behaviors. Pusa Bold recorded higher plant height, number of leaves and leaf area at all stages of growth than Kranti (Table 1). Higher dose of fertilizer (N_{100} P_{50} kg ha^{-1}) resulted in increased whereas lower dose of fertilizers below normal (N_{60} P_{30} kg ha^{-1}) resulted in decreased plant height, number of leaves and leaf area. Increase in plant height due to higher dose of fertilizer application was 10.7, 7.8, 4.0 and 3.6 per cent while decrease in plant height due to lower dose of fertilizer was 13.4, 6.9, 4.9 and 4.3 per cent, respectively at vegetative, flowering, siliqua development and maturity as compared to the normal dose of fertilizers (N_{80} P_{40} kg h^{-1}). Increased number and area of leaves at vegetative, flowering and siliqua development stages were 13.4, 8.0, and 12.8 per cent and 23.2, 14.0 and 19.6 per cent, respectively. Whereas, an 11.2, 10.4 and 13.9 per cent and 24.0, 26.1 and 28.0 per cent decrease were recorded at corresponding stages due to lowered fertilizer doses. Interaction effect of cultivars and fertilizers were also found significant with all the parameters. Both nitrogen and phosphorus are structural components of bimolecules like proteins, phospholipids nucleic acids, etc. and accelerate the metabolic processes of plants. Being an integral part of ATP, phosphorus also plays an indispensable role in energy metabolism (Marschner 1986). Thus both of these plant nutrients play an important role in increasing the plant height and foliage development by providing the energy and stimulating cell division and elongation (Devlin and Witham 1986). The supply of high concentration of nitrogen increased leaf cell number and size with an overall increase in leaf production. It is also evident from the data that increase in plant height and leaf development were faster from vegetative to flowering stage than other stages which might be due to a more increase in cell elongation than cell division. An accelerated growth during this phase may also be attributed to the application of second dose of nitrogen at 30 DAS. A decrease in green leaf area was noted after flowering stage. The decrease in leaf area from flowering to siliqua development was due to senescene of leaves as a result of diversion of assimilates to reproductive sinks. These findings are in conformity with those of Prasad and Shukla (1991).

Pusa Bold produced more number of branches and dry matter as compared to Kranti. Higher dose of fertilizers (N_{100} P_{50} kg ha^{-1}) increased the branching by 15.5, 8.7, 11.3 and 12.6 per cent and dry matter production by 9.6, 19.3, 12.3 and 13.5 per cent, respectively at vegetative, flowering, siliqua development and maturity stages as compared to normal dose. Similarly deceased fertilizer dose below the normal resulted in a decease in branching by 8.2, 7.3, 8.8 and 9.4 per cent and dry matter by 21.3, 10.5, 8.0 and 9.7 per cent. All the treatment interactions between the cultivars and N and P fertilizer doses were found to be significant. Increase in the number of primary branches due to increased level of nitrogen and phosphorus

Table 1. Effect of varying levels of nitrogen and phosphorus on plant height, leaf number and leaf area at different stages in mustard cultivars

Treatment	Plant height (cm)				No. of leaves (plant^{-1})			Leaf area (cm^2 plant^{-1})		
	Vegetative	Flowering	Siliqua development	Maturity	Vegetative	Flowering	Siliqua development	Vegetative	Flowering	Siliqua development
Cultivars										
Pusa Bold	14.05	128.32	168.96	179.54	7.59	32.42	22.33	455.55	841.99	644.89
Kranti	13.30	125.92	163.47	174.28	6.77	29.89	19.19	405.96	772.79	571.13
C.D (P=0.05)	**0.314**	**1.916**	**2.505**	**2.665**	**0.215**	**0.709**	**0.625**	**9.72**	**30.42**	**22.91**
Fertilizers (Kg/ha)										
N_{60} P_{30} K_{40}	11.94	117.89	158.44	169.56	6.38	28.13	17.93	327.57	621.41	450.27
N_{80} P_{40} K_{40}	13.80	126.73	166.70	177.34	7.19	31.40	20.84	432.20	841.37	625.51
N_{100} P_{50} K_{40}	15.28	136.74	173.51	183.83	8.16	33.94	23.51	532.49	959.39	748.24
C.D. (P=0.05)	**0.385**	**2.346**	**3.068**	**3.264**	**0.264**	**0.868**	**0.766**	**11.90**	**37.26**	**28.06**
Interactions										
Pusa Bold x N_{60} P_{30} K_{40}	12.16	119.23	161.45	172.88	6.94	29.22	19.53	346.23	650.18	482.23
Pusa Bold x N_{80} P_{40} K_{40}	14.15	127.52	168.74	179.32	7.43	32.45	22.18	452.15	880.46	664.28
Pusa Bold x N_{100} P_{50} K_{40}	15.85	138.21	176.63	186.44	8.72	35.61	25.29	568.27	995.35	788.32
Kranti x N_{60} P_{30} K_{40}	11.73	116.65	155.43	166.25	5.82	27.05	16.33	308.91	592.64	418.32
Kranti x N_{80} P_{40} K_{40}	13.45	125.94	164.65	175.35	6.95	30.36	19.51	412.26	802.29	586.75
Kranti x N_{100} P_{50} K_{40}	14.72	135.28	170.35	181.29	7.60	32.28	21.74	496.72	923.44	708.33
C.D. (P=0.05)	**0.545**	**3.316**	**4.339**	**4.618**	**0.374**	**1.228**	**1.083**	**16.83**	**52.69**	**39.68**

fertilizers has also been reported by Gulzar *et al*. (1989). The increased amounts of nutrients made available through fertilization and enhanced growth of the plant assimilatory surface could be attributed to more dry matter production. These findings are supported by various studies (Singh and Singh 1984, Rathod *et al*. 2001).

Data indicated that Pusa Bold had significantly higher nitrogen and potassium contents at siliqua development and flowering stages, respectively, whereas no significant differences were found between the cultivars with respect to phosphorus content (Table 3). Different levels of fertilizers registered significant differences in nutrient contents at flowering and siliqua development stages, and the maximum nitrogen (3.91 and 2.89 per cent), phosphorus (0.49 and 0.33 per cent) and potassium (3.88 and 2.91 per cent) contents of leaf were recorded with higher dose of N and P fertilizers at flowering and siliqua development stages, respectively. Similarly, application of lower fertilizer dose caused a significant decrease in leaf nutrient contents. In general all the three nutrient levels were relatively higher at flowering than siliqua development stage. The higher content of N and P might be as a consequence of increased supply and uptake of both nutrients. Phosphorus has a favorable effect on root

Table 2. Effect of varying levels of nitrogen and phosphorus on number of primary branches and total dry matter production in mustard cultivars

Treatment	No. of primary branches (plant^{-1})				Total dry matter (g plant^{-1})			
	Vegetative	Flowering	Siliqua development	Maturity	Vegetative	Flowering	Siliqua development	Maturity
Cultivars								
Pusa Bold	5.74	6.07	6.35	7.20	3.79	19.05	37.05	41.77
Kranti	5.18	5.37	5.73	6.24	3.59	16.56	34.66	39.14
C.D (P=0.05)	**0.280**	**0.258**	**0.227**	**0.298**	**0.171**	**1.006**	**1.621**	**1.982**
Fertilizers (Kg/ha)								
N_{60} P_{30} K_{40}	4.77	5.28	5.46	6.02	3.02	15.48	32.51	36.07
N_{80} P_{40} K_{40}	5.20	5.70	5.99	6.65	3.84	17.30	35.36	39.95
N_{100} P_{50} K_{40}	6.01	6.20	6.67	7.49	4.21	20.64	39.71	45.35
C.D. (P=0.05)	**0.343**	**0.317**	**0.278**	**0.365**	**0.21**	**1.232**	**1.985**	**2.427**
Interactions								
Pusa Bold x N_{60} P_{30} K_{40}	4.82	5.76	5.83	6.55	3.1	16.70	33.72	37.42
Pusa Bold x N_{80} P_{40} K_{40}	5.86	5.95	6.34	7.15	3.9	18.50	36.52	41.22
Pusa Bold x N_{100} P_{50} K_{40}	6.35	6.52	6.88	7.86	4.37	21.97	40.99	46.69
Kranti x N_{60} P_{30} K_{40}	4.73	4.80	5.10	5.50	2.94	14.26	31.36	34.73
Kranti x N_{80} P_{40} K_{40}	5.15	5.45	5.64	6.10	3.78	16.10	34.21	38.68
Kranti x N_{100} P_{50} K_{40}	5.68	5.68	6.40	7.12	4.05	19.32	38.44	44.01
C.D. (P=0.05)	**NS**	**0.448**	**0.394**	**0.518**	**NS**	**NS**	**2.808**	**3.433**

growth, which resulted in better absorption and uptake of other nutrients. Enhancement in rate of metabolic processes with higher dose of N and P may also result in an increased demand and utilization of other plant nutrients, among which K is of prime importance. A synergistic role of K with both N and P has already been established (Mandal *et al*. 2002).

Pusa Bold had higher number and length of siliqua as well as number of seeds as compared to cultivar Kranti. Higher dose of fertilizers increased number of siliqua, length of siliqua and number of seeds per siliqua by 11.5, 9.2 and 8.2 per cent, whereas the lower fertilizer dose decreased them by 8.6, 8.1 and 7.3 per cent, respectively as compared to the recommended dose of fertilizers (Table 4). The data also indicated that cultivar Pusa Bold had higher harvest index (32.50 %) test weight (6.32 g) and seed yield (14.50 g plant^{-1}) as compared to Kranti having 30.64% harvest index, 5.5.7 g test weight and 13.18 g seed yield plant^{-1}. Higher dose of fertilizer significantly increased harvest index and seed yield as compared to normal recommended dose. The increased yield per plant due to increased fertilizer dose is the result of improved yield attributing characters like number and length of siliqua and number of seeds per plant. These findings are in conformity with the work of Puri *et al*. (1999).

Pusa bold had higher contents of oil and protein as compared to Kranti (Table. 4). Decreasing fertilizer dose increased oil content and decreased protein content by 1.77 and 3.2 per cent, respectively. However, higher dose of fertilizers decreased oil and increased seed protein contents by 2.18 and 2.65 per cent, respectively. Interactions of both cultivars and fertilizer doses also affected these parameters significantly. However, in

Table 3. Effect of varying levels of nitrogen and phosphorus on leaf nitrogen, phosphorus and potassium content of mustard

Treatments	Leaf nitrogen content (%)		Leaf phosphorus content (%)		Leaf potossium content (%)	
	Flowering	Siliqua development	Flowering	Siliqua development	Flowering	Siliqua development
Cultivars						
Pusa bold	3.66	2.69	0.42	0.28	3.65	2.63
Kranti	3.53	2.53	0.41	0.28	3.53	2.59
CD (P=0.05)	**NS**	**0.082**	**NS**	**NS**	**0.053**	NS
Fertilizers (Kg/ha)						
N_{60} P_{30} K_{40}	3.23	2.3	0.33	0.22	3.35	2.27
N_{80} P_{40} K_{40}	3.65	2.65	0.42	0.28	3.54	2.65
N_{100} P_{50} K_{40}	3.91	2.89	0.49	0.33	3.88	2.91
CD (P=0.05)	**0.172**	**0.101**	**0.069**	**0.038**	**0.065**	**0.072**
Interactions						
Pusa Bold x N_{60} P_{30} K_{40}	3.24	2.41	0.34	0.23	3.42	2.27
Pusa Bold x N_{80} P_{40} K_{40}	3.76	2.72	0.43	0.28	3.60	2.68
Pusa Bold x N_{100} P_{50} K_{40}	3.98	2.96	0.49	0.33	3.95	2.96
Kranti x N_{60} P_{30} K_{40}	3.02	2.20	0.32	0.22	3.29	2.28
Kranti x N_{80} P_{40} K_{40}	3.54	2.58	0.42	0.28	3.48	2.62
Kranti x N_{100} P_{50} K_{40}	3.85	2.83	0.50	0.34	3.82	2.87
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 4. Effect of varying levels of nitrogen and phosphorus on yield and yield attributes in mustard cultivars

Treatments	No. of siliqua (plant^{-1})	Length of siliqua (cm)	No. of seeds (siliqua^{-1})	1000-seed weight (g)	Seed yield (g plant^{-1})	Harvest index (%)	Oil content (%)	Protein content (%)
Cultivars								
Pusa Bold	218.89	5.27	12.13	6.32	14.50	32.50	39.72	24.37
Kranti	202.17	4.88	11.47	5.57	13.18	30.64	38.09	26.06
C.D (P=0.05)	**4.76**	**0.114**	**0.355**	**0.143**	**0.521**	**0.713**	**0.697**	**0.292**
Fertilizers (Kg/ha)								
N_{60} P_{30} K_{40}	190.41	4.65	10.90	5.93	12.76	30.18	39.65	24.47
N_{80} P_{40} K_{40}	208.54	5.06	11.77	5.95	13.91	31.59	38.96	25.25
N_{100} P_{50} K_{40}	232.64	5.53	12.74	5.96	14.85	32.94	38.11	25.92
C.D. (P=0.05)	**5.829**	**0.139**	**0.435**	**NS**	**0.638**	**0.275**	**0.569**	**0.358**
Interactions								
Pusa Bold x N_{60} P_{30} K_{40}	198.32	4.87	11.05	6.31	13.21	31.05	40.38	23.56
Pusa Bold x N_{80} P_{40} K_{40}	218.45	5.23	12.12	6.32	14.56	32.65	39.58	24.57
Pusa Bold x N_{100} P_{50} K_{40}	239.92	5.72	13.24	6.34	15.74	33.82	39.21	24.98
Kranti x N_{60} P_{30} K_{40}	182.51	4.43	10.76	5.56	12.32	29.32	38.92	25.38
Kranti x N_{80} P_{40} K_{40}	198.64	4.89	11.42	5.58	13.26	30.53	38.34	25.93
Kranti x N_{100} P_{50} K_{40}	225.37	5.34	12.25	5.59	13.97	32.07	37.02	26.87
C.D. (P=0.05)	**8.244**	**NS**	**0.616**	**NS**	**0.903**	**1.235**	**0.987**	**0.507**

spite of this decrease in per cent oil content, the overall yield of oil obtained was higher under higher dose of N and P fertilizers, due to comparatively more increase in seed yield than decrease in oil content. An increase in seed protein with increased supply of nitrogen was also observed by Dubey and Khan (1996).

The present study therefore indicated that application of N and P fertilizers at a higher dose (N_{100} P_{50} kg ha^{-1}, i.e. 25% above normal recommended dose) may be advantageous in terms of plant growth, seed yield and quality of mustard.

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