

EFFECT OF NITROGEN AND PHOSPHORUS LEVELS AND RATIOS ON SEED YIELD AND NUTRIENT UPTAKE OF SUNFLOWER HYBRID DSH-I

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SUMMARY

A field experiment was conducted on medium black clayey soils under rainfed conditions at Main Research Station, University of Agricultural Sciences (UAS), Dharwad, India, during *kharif* 1999 to study the effect of different levels and ratios of nitrogen and phosphorus on seed yield and nutrient uptake of the sunflower hybrid DSH-1. The experiment consisted of nine treatments, i.e., N/P ratios with two N/P ratios of <1.0 (0.67 and 0.80), N/P ratio of 1.0 consisting of two ratios and four N/P ratios of >1.0 (1.20, 1.30, 1.60 and 2.00) along with control (no nitrogen and phosphorus) as keeping potassium level ($60 \text{ kg K}_2\text{O ha}^{-1}$) as constant. The results showed that nitrogen and phosphorus applied in N/P ratios of >1.0 with 2.00 : 1.25 : 1.00 fertilizer level and N/P ratio of 1.0 with 2.00 : 2.00 : 1.00 fertilizer level produced 21 and 27 percent higher seed yield over the UAS, Dharwad fertilizer recommendation, i.e., N/P ratio of <1.0 with 1.00 : 1.25 : 1.00 fertilizer level (2800 kg ha^{-1}). At maturity, higher nitrogen (177.72 kg and $186.27 \text{ kg N ha}^{-1}$), phosphorus (23.66 kg and $27.75 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$) and potassium (124.85 kg and $126.68 \text{ kg K}_2\text{O ha}^{-1}$) uptakes were obtained in the treatment receiving N/P ratio of >1.0 with 2.00 : 1.25 : 1.00 (120 kg N , $75 \text{ P}_2\text{O}_5$ and $60 \text{ kg K}_2\text{O ha}^{-1}$) and in the treatment receiving N/P ratio of 1.0 with 2.00 : 2.00 : 1.00 (120 kg N , $120 \text{ P}_2\text{O}_5$ and $60 \text{ kg K}_2\text{O ha}^{-1}$) fertilizer levels as compared with the UAS, Dharwad fertilizer recommendation, i.e., N/P ratio of < 1.0 with 1.00 : 1.25 : 1.00 (60 kg N , $75 \text{ P}_2\text{O}_5$ and $60 \text{ kg K}_2\text{O ha}^{-1}$).

Key words: N/P ratio, nitrogen uptake, phosphorus uptake, potassium uptake, sunflower

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop which ranks third next to soybean and groundnut as a source of edible oil in the world. In India, sunflower was introduced in early seventies and holds as a potential oil seed crop

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in the present oil crisis due to its desirable attributes such as early maturity, adaptability to wide range of climate and soil conditions, photo- and thermo insensitive, and drought tolerance. Though the crop has gained important place among farmers, the productivity of sunflower in India is much lower than the world's average. The low productivity is mainly due to the crop growing under rainfed conditions on poor-fertility soils and with inadequate plant protection measures. Sunflower is often considered as a soil-depleting crop which puts heavy demands on soil and applied nutrients (Kharwara and Bindra, 1992; Mishra *et al.*, 1994). Due to its high uptake of nutrients, sunflower responds very well to applied nutrients. Applications of nutrients increased the seed yield of sunflower by 50 percent (Chorey and Thosar, 1997). Among the different nutrients required by sunflower, nitrogen and phosphorus are the primary limiting nutrients under most environments (Devidayal and Agarwal, 1998; Baldev Raj *et al.*, 1999). Further, little information is currently available in India on the effect of nitrogen and phosphorus fertilizers applied in different N/P*(P₂O₅ is referred as P) ratios. Because of the paucity of adequate experimental data under rainfed condition, the present study was carried out to know the seed yield and nutrient uptake of sunflower as influenced by different nitrogen and phosphorus levels and ratios.

MATERIALS AND METHODS

A field experiment was carried out during *kharif* 1999 at Main Research Station, University of Agricultural Sciences, Dharwad, India. The soil was clayey in texture, medium in organic carbon (0.62%), low in available nitrogen (270.61 kg N ha⁻¹), medium in available phosphorus (40.85 kg P₂O₅ ha⁻¹) and high in available potassium (436.61 kg K₂O ha⁻¹) having pH of 7.7. The experiment was laid out in a randomized complete block design (RCBD) with four replications. Nine treatments (N/P ratios) with two treatments had the N/P ratio of <1.0 (0.67 and 0.80), and two treatments with N/P ratios of 1.0 and four treatments are having N/P ratios of >1.0 (1.20, 1.30, 1.60 and 2.00) including control (no nitrogen and phosphorus) with a constant level of potassium (60 kg K₂O ha⁻¹). The pretreated (Metalaxyl + Mancozeb at 4 g ha⁻¹ seeds) sunflower hybrid seeds were hand dibbled at a spacing of 60 x 30 cm. The fertilizers, nitrogen, phosphorus and potassium, were applied in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively. The required quantity of fertilizer mixture containing half dose of nitrogen and the entire quantities of phosphorus and potassium were applied in the furrows as per the treatment to each plot at the time of sowing. Top dressing of nitrogen in the form of urea was done as band placement 40 days after sowing (DAS). Experimental plots were kept weed-free by integrated weed management practices involving pre-emergence application of metolachlor (30 EC) at 1 kg a.i., ha⁻¹ + two inter cultivations at 20 and 35 DAS + one hand weeding at 30 DAS. As precautionary measures, the crop rows were drenched with endosulfan (35 EC) at

0.2 percent and poison baiting of monochrotophos (36 SL) were carried out to control cutworms (*Agrotis ipsilon* and *A. segetum*). As a preventive measure against downy mildew and *Alternaria* leaf spot diseases, the crop was sprayed with Metalaxyl + Mancozeb (72 WP) at 0.6 percent and Mancozeb (75 WP) at 0.2 percent, respectively. The crop was harvested when it attained maturity. The plant samples were taken at seedling (25 DAS), button (45 DAS), flowering (65 DAS), seed formation (78 DAS) and maturity (87 DAS) stages. The plant samples were analyzed by micro kjeldahl's, vanado molybdo phosphoric yellow color and flame photometer methods for nitrogen, phosphorus and potassium content, respectively. The data collected at different stages were subjected to statistical analysis as described by Gomez and Gomez (1984). The treatment means were compared by using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

The seed yield of sunflower was increased by increasing the N/P ratio from 0.67 to 2.00 (Table 1). Generally, the treatments receiving N/P ratio (P_2O_5 is referred as P) of >1.0 and N/P ratio of 1.0 produced higher seed yields (3009 to 3397 kg and 2875 to 3554 kg ha⁻¹, respectively) when compared with the treatments receiving N/P ratio of <1.0 and control (2761 to 2800 kg and 1949 kg ha⁻¹, respectively). Further, among the treatments receiving N/P ratio of >1.0 , 2.00 : 1.25 : 1.00 fertilizer level produced higher seed yield (3397 kg ha⁻¹) over the other levels. Similarly, in the treatments receiving N/P ratio of 1.0, higher seed yield (3554 kg ha⁻¹) was noticed with 2.00 : 2.00 : 1.00 fertilizer level of 1.50 : 1.50 : 1.00. Singh and Singh (1997) were also obtained higher seed yields of sunflower with N/P ratio of >1.0 .

Higher seed yields of sunflower obtained in differed treatments were mainly due to improvement in the yield components. The treatments receiving N/P ratio of >1.0 with 2.00 : 1.25 : 1.00 fertilizer level and the treatment receiving N/P ratio of 1.0 with 2.00 : 2.00 : 1.00 fertilizer level produced larger heads (20.69 and 20.91 cm diameter, respectively), more head weight at harvest (94.80 and 95.84 g, respectively), more seed weight plant⁻¹ (62.61 and 66.66 g, respectively) and more 1000-seed weight (44.61 and 51.56 g, respectively), as compared with the treatments receiving N/P ratio of <1.0 with 1.00 : 1.25 : 1.00 fertilizer level (16.68 cm diameter, 82.34, 52.80 and 44.16 g, respectively). Similar observations were made by several workers, where head size (Singh and Singh, 1997; Baldev Raj *et al.*, 1999), head weight at harvest (Megur, 1988) seed weight plant⁻¹ (Meszaros and Simits, 1992; Baldev Raj *et al.*, 1999) and 1000-seed weight (Singh and Singh, 1997) were increased due to nitrogen and phosphorus applied in N/P ratio of 1.0 and >1.0 . The higher head weight plant⁻¹ at harvest and higher seed weight plant⁻¹ in the treatments receiving N/P ratio of 1.0 and >1.0 were due to increased head size and increased percent of filled seeds head⁻¹, respectively.

Table 1: Head diameter (cm), head weight (g plant⁻¹), seed weight (g plant⁻¹) and 1000-seed weight (g) as influenced by nitrogen and phosphorus fertilization**

Sl. No.	Treatment										
	Nutrient ratio			Quantity of nutrients (kg ha ⁻¹)			Head diameter (cm)	Head weight (g plant ⁻¹)	Seed weight (g plant ⁻¹)	1000-seed weight (g)	Seed yield (kg ha ⁻¹)
	N	P ₂ O ₅	K ₂ O	N/P ₂ O ₅	N	P ₂ O ₅					
1	0.00	0.00	1.00	0.00	0	60	13.04 c*	59.34 c	33.87 c	36.10 e	1949 e*
2	1.00	1.25	1.00	0.80	60	75	16.68 b	82.39 b	52.80 b	44.16 c	2800 d
3	1.00	1.50	1.00	0.67	60	90	16.93 b	82.49 b	53.67 b	47.87 b	2761 d
4	1.50	1.25	1.00	1.20	90	75	18.03 b	87.60 b	53.92 b	44.45 c	3009 cd
5	1.50	1.50	1.00	1.00	90	90	18.07 b	87.40 b	54.90 b	47.96 b	2875 d
6	2.00	1.00	1.00	2.00	120	60	20.73 a	94.11 a	62.46 a	40.98 d	3188 bc
7	2.00	1.25	1.00	1.60	120	75	20.69 a	94.80 a	62.61 a	44.61 c	3397 ab
8	2.00	1.50	1.00	1.30	120	90	20.76 a	95.44 a	62.67 a	47.88 b	3220 bc
9	2.00	2.00	1.00	1.00	120	120	20.91 a	95.84 a	66.66 a	51.56 a	3554 a
Mean							18.43	86.60	55.95	45.06	

* In a column mean values followed by the same letter do not differ significantly at P=0.05 by DMRT

** Above ground mass

DAS-Days after sowing

Table 2: Total nitrogen uptake** (kg N ha⁻¹) by sunflower at different growth stages as influenced by nitrogen and phosphorus fertilization

Sl. No.	Treatment										Total nitrogen uptake (kg N ha ⁻¹)				
	Nutrient ratio					Quantity of nutrients (kg ha ⁻¹)					Seedling stage (25 DAS)	Button stage (45 DAS)	Flowering stage (65 DAS)	Seed formation stage (78 DAS)	Maturity stage (87 DAS)
	N	P ₂ O ₅	K ₂ O	N/P ₂ O ₅	N/P ₂ O ₅	N	P ₂ O ₅	K ₂ O	P ₂ O ₅	K ₂ O					
1	0.00	0.00	1.00	0.00	0.00	0	0	60	0	60	2.21 d *	50.90 d	85.90 d	76.85 d	54.98 d
2	1.00	1.25	1.00	0.80	0.80	60	75	60	60	60	5.15 c	93.96 c	174.66 c	163.29 c	122.64 c
3	1.00	1.50	1.00	0.67	0.67	60	90	60	60	60	5.25 c	98.31 c	185.28 c	167.23 c	126.58 c
4	1.50	1.25	1.00	1.20	1.20	90	75	60	60	60	6.13 b	110.93 b	202.05 b	190.45 b	144.62 b
5	1.50	1.50	1.00	1.00	1.00	90	90	60	60	60	6.53 b	115.75 b	206.88 b	193.59 b	149.01 b
6	2.00	1.00	1.00	2.00	2.00	120	60	60	60	60	7.38 a	127.39 a	243.94 a	220.48 a	175.10 a
7	2.00	1.25	1.00	1.60	1.60	120	75	60	60	60	7.13 a	133.62 a	250.98 a	220.49 a	177.72 a
8	2.00	1.50	1.00	1.30	1.30	120	90	60	60	60	7.29 a	134.30 a	254.85 a	227.79 a	178.76 a
9	2.00	2.00	1.00	1.00	1.00	120	120	60	60	60	7.63 a	136.59 a	258.94 a	233.90 a	186.27 a
Mean											6.08	111.31	207.05	188.23	146.19

* In a column mean values followed by the same letter do not differ significantly at P=0.05 by DMRT

** Above ground mass DAS-Days after sowing

Higher seed yields in the treatments receiving N/P ratio of >1.0 or 1.0 were also due to better uptake of nutrients by sunflower. Total nitrogen (N), total phosphorus (P_2O_5) and total potassium (K_2O) uptakes were increased due to increasing N/P ratios from 0.67 to 2.00 at all the growth stages. Nutrient uptake dropped off slowly and steadily with advance in age of plant growth. Maximum nutrient uptake was noticed at flowering stage. This is mainly due to the higher biomass at flowering stage and decreasing trend of plant nutrients with advancing growth of plant.

Total nitrogen (N) uptake was significant due to nitrogen and phosphorus fertilization. At all the stages, the treatments receiving N/P ratios of >1.0 and 1.0 recorded higher total nitrogen uptakes as compared with N/P ratios of <1.0 and control (Table 2). At maturity stage, the treatment receiving N/P ratio of >1.0 with $2.00 : 1.25 : 1.00$ fertilizer level and N/P ratio of 1.0 with $2.00 : 2.00 : 1.00$ fertilizer level recorded higher uptake (177.72 and 186.27 kg N ha⁻¹, respectively) as compared with N/P ratio of <1.0 with $1.00 : 1.25 : 1.00$ fertilizer level and control (122.64 and 54.98 kg ha⁻¹, respectively). This increase in nitrogen uptake might be due to increased nitrogen availability to plants for higher biomass production in the treatments receiving N/P ratio of >1.0 and 1.0 . This confirms the results reported by Hiremath *et al.* (1992) who observed increased nitrogen uptake in the treatments N/P ratio of 1.0 .

Nitrogen and phosphorus fertilizers significantly influenced the phosphorus (P_2O_5) uptake also (Table 3). At maturity stage, the treatments receiving N/P ratio of >1.0 with $2.00 : 1.25 : 1.00$ fertilizer level and N/P ratio of 1.0 with $2.00 : 2.00 : 1.00$ fertilizer level recorded higher phosphorus uptakes (23.60 kg and 27.71 kg P_2O_5 ha⁻¹, respectively) as compared with N/P ratio of <1.0 with $1.00 : 1.25 : 1.00$ fertilizer level and control (19.44 kg and 10.44 kg P_2O_5 ha⁻¹, respectively). At higher N/P ratios, better utilization of the applied phosphorus in the presence of higher nitrogen must result in higher phosphorus uptake. The greater mobilization of phosphorus in the presence of nitrogen was reported by Hocking and Steer (1983). Mishra *et al.* (1995) found a higher uptake of phosphorus when nitrogen and phosphorus fertilizers were applied in N/P ratio of 1.0 .

Effect of nitrogen and phosphorus on total potassium (K_2O) uptake was significant at all the growth stages. Still, potassium uptake was similar to nitrogen uptake (Table 4).

CONCLUSION

Based on the results obtained from the present study, the treatment receiving N/P ratio of >1.0 with $2.00 : 1.25 : 1.00$ fertilizer level and N/P ratio of 1.0 with $2.00 : 2.00 : 1.00$ fertilizer level produced 21 and 27 percent higher seed yield over University of Agricultural Sciences, Dharwad, recommendation, i.e., $1.00 : 1.25 : 1.00$ fertilizer level. The treatments receiving N/P ratio of >1.0 with $2.00 : 1.25 : 1.00$ (120 kg N, 75 kg P_2O_5 and 60 kg K_2O ha⁻¹) fertilizer level and N/P ratio of 1.0 with $2.00 : 2.00 : 1.00$ (120 kg N, 120 kg P_2O_5 and 60 kg K_2O ha⁻¹) fertilizer level resulted in higher total nitrogen (N) uptake by 44.91 and 50.31 percent, respectively, over N/P ratio of <1.0 with $1.00 : 1.25 : 1.00$ (60 kg N, 75 kg P_2O_5 and

Table 3: Total phosphorus uptake** (kg P₂O₅ ha⁻¹) by sunflower at different growth stages as influenced by nitrogen and phosphorus fertilization

Sl. No.	Treatment										Total phosphorus uptake (kg P ₂ O ₅ ha ⁻¹)				
	Nutrient ratio			Quantity of nutrients (kg ha ⁻¹)			Seedling stage (25 DAS)	Button stage (45 DAS)	Flowering stage (65 DAS)	Seed formation stage (78 DAS)	Maturity stage (87 DAS)				
	N	P ₂ O ₅	K ₂ O	N/P ₂ O ₅	N	P ₂ O ₅						K ₂ O			
1	0.00	0.00	1.00	0.00	0	0	60	0.19 e	6.32 e	14.81 e	11.38 e	10.44 e			
2	1.00	1.25	1.00	0.80	60	75	60	0.57 d	10.83 d	26.59 d	21.50 d	19.44 d			
3	1.00	1.50	1.00	0.67	60	90	60	0.71 c	12.57 c	30.11 c	25.19 c	22.44 c			
4	1.50	1.25	1.00	1.20	90	75	60	0.59 d	11.15 d	26.01 d	23.15 d	19.37 d			
5	1.50	1.50	1.00	1.00	90	90	60	0.75 c	12.64 c	30.25 c	25.21 c	22.03 c			
6	2.00	1.00	1.00	2.00	120	60	60	0.60 d	11.20 d	26.68 d	22.90 d	19.69 d			
7	2.00	1.25	1.00	1.60	120	75	60	0.74 c	13.10 c	30.89 c	25.92 c	23.66 c			
8	2.00	1.50	1.00	1.30	120	90	60	0.87 b	16.14 b	36.09 b	28.03 b	25.65 b			
9	2.00	2.00	1.00	1.00	120	120	60	0.98 a	17.95 a	38.93 a	29.98 a	27.71 a			
	Mean										0.67	12.43	28.92	23.70	21.14

* In a column mean values followed by the same letter do not differ significantly at P=0.05 by DMRT

** Above ground mass DAS-Days after sowing

Table 4: Total potassium uptake** (kg K₂O ha⁻¹) by sunflower at different growth stages as influenced by nitrogen and phosphorus fertilization

Sl. No.	Treatment										Total potassium uptake (kg K ₂ O ha ⁻¹)								
	Nutrient ratio					Quantity of nutrients (kg ha ⁻¹)					Seedling stage (25 DAS)	Button stage (45 DAS)	Flowering stage (65 DAS)	Seed formation stage (78 DAS)	Maturity stage (87 DAS)				
	N	P ₂ O ₅	K ₂ O	N/P ₂ O ₅	N/P ₂ O ₅ K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅						K ₂ O			
1	0.00	0.00	1.00	0.00	0.00	0	0	60	1.15	d *	38.87	d	81.28	d	68.93	d	50.58	d	
2	1.00	1.25	1.00	0.80	0.80	60	75	60	2.68	c	59.09	c	137.21	c	122.77	c	89.18	c	
3	1.00	1.50	1.00	0.67	0.67	60	90	60	2.90	c	64.12	c	142.43	c	130.88	c	95.96	c	
4	1.50	1.25	1.00	1.20	1.20	90	75	60	3.06	b	72.82	b	157.76	b	145.49	b	105.22	b	
5	1.50	1.50	1.00	1.00	1.00	90	90	60	3.10	b	74.64	b	165.17	b	152.22	b	109.46	b	
6	2.00	1.00	1.00	2.00	2.00	120	60	60	3.46	a	84.08	a	183.14	a	164.01	a	119.28	a	
7	2.00	1.25	1.00	1.60	1.60	120	75	60	3.49	a	86.66	a	190.02	a	166.88	a	124.85	a	
8	2.00	1.50	1.00	1.30	1.30	120	90	60	3.56	a	88.69	a	192.80	a	168.71	a	126.05	a	
9	2.00	2.00	1.00	1.00	1.00	120	120	60	3.65	a	91.24	a	194.02	a	172.03	a	126.68	a	
	Mean										3.00	73.36	160.43	143.54	105.24				

*In a column mean values followed by the same letter do not differ significantly at P=0.05 by DMRT

**Above ground mass
DAS-Days After Sowing

60 kg K₂O ha⁻¹) fertilizer level (122.64 kg N ha⁻¹). Similarly, at maturity stage, increased phosphorus uptake (from 19.44 to 27.71 kg and from 19.44 to 23.60 kg P₂O₅ ha⁻¹) and potassium uptake (from 89.18 to 124.85 kg and 89.18 to 126.68 kg K₂O ha⁻¹) were noticed due to the nitrogen and phosphorus fertilizer applied at N/P ratios from <1.0 with 1.00 : 1.25 : 1.00 to N/P ratio of >1.0 with 2.00 : 1.25 : 1.00 and N/P ratio of 1.0 with 2.00 : 2.00 : 1.00 fertilizer levels, respectively.

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LA INFLUENCIA DE DIFERENTES CANTIDADES Y PROPORCIONES DE NITRÓGENO Y DE FÓSFORO EN LA ADOPCIÓN DE LAS MATERIAS NUTRITIVAS EN HÍBRIDOS

RESUMEN

El experimento del campo se ha realizado en el suelo arcilloso medio negro en la Estación Principal de Investigaciones de la Universidad de las Ciencias Agrícolas (UCA) en Dharwad (La India) durante la temporada *kharif* de

1999, con el fin de estudiar la influencia de las diferentes cantidades y las proporciones mutuas del nitrógeno (N) y fósforo (P) en el rendimiento de semilla y adopción de las materias nutritivas en los híbridos de girasol DSH-1. El experimento constaba de nueve variantes, es decir: de nueve diferentes proporciones de N y P (dos variantes con relación $<1,0$ (0,67 y 0,80), dos con relación 1,0 y cuatro con $>1,0$ (1,20, 1,30, 1,60 y 2,00), tanto como una variante control, sin estos dos elementos), donde la dosis de potasio siempre ha sido igual (60 kg K_2O ha^{-1}). Los resultados de la investigación han demostrado que la aplicación de nitrógeno y de fósforo en la proporción de 2,00:1,25:1,00 ($>1,0$) ha aumentado el rendimiento de semilla para 21%, y la aplicación en la proporción 2,00:2,00:1,00 (1,0) para 27% en relación con la dosis de fertilizante de 1,00:1,25:1,00 ($<1,00$), es decir: 2.800 kg ha^{-1} , la cual UCA de Dharwad, recomienda. En la fase de madurez, mayor adopción de nitrógeno (177,72 y 186,27), fósforo (23,66 i 27,75 kg P ha^{-1}) y potasio (124,85 y 126,68 kg K_2O ha^{-1}) se obtuvo en las variantes fertilizadas con N/P 2,00:1,25:1,00 ($>1,0$) (120 kg N, 75 kg P_2O_5 y 60 kg K_2O) y N/P 2,00:2,00:1,00 (1,0) (120 kg N, 120 kg P_2O_5 y 60 kg K_2O) en relación con la recomendación de UCA de Dharwad de 1,00:1,25:1,00 ($<1,00$) (60 kg N, 75 kg P_2O_5 y 60 kg K_2O).

EFFET DE DIFFÉRENTES QUANTITÉS ET PROPORTIONS D'AZOTE ET DE PHOSPHORE SUR L'ABSORPTION DE MATIÈRES NUTRITIVES PAR L'HYBRIDE DE TOURNESOL (DSH-1)

RÉSUMÉ

Une expérience a été faite sur un sol argileux noir moyen à la station de recherche principale de l'université des sciences agricoles (UAS) de Dharwad en Inde pendant la saison de *kharif* 1999 pour que soit examiné l'effet de différentes quantités et proportions d'azote (N) et de phosphore (P) sur le rendement en semences et l'absorption de matières nutritives par l'hybride de tournesol DSH-1. L'expérience comprenait neuf variantes, c'est-à-dire neuf différentes proportions de N et de P (deux variantes dans le rapport $<1,0$ (0,67 et 0,80), deux dans le rapport 1,0, et quatre dans le rapport $>1,0$ (1,20, 1,30, 1,60 et 2,00) ainsi qu'un variante de contrôle sans ses deux éléments, la dose de potassium était toujours la même (60 kg K_2O ha^{-1}). Les résultats de la recherche ont montré que l'administration d'azote et de phosphore dans une proportion de 2,00:1,25:1,00 ($>1,0$) avait augmenté le rendement en semences de 21% et l'administration d'azote et de phosphore dans la proportion de 2,00:2,00:1,00 (1,0) de 27% en comparaison avec la dose d'engrais de 1,00:1,25:1,00 ($<1,00$), c'est-à-dire 2.800 kg ha^{-1} , conseillée par l'UPN de Dharwad. Dans la phase de maturité une plus grande absorption d'azote (177,72 et 186,27), de phosphore (23,66 et 27,75 kg P ha^{-1}) et de potassium (124,85 et 126,68 kg K_2O ha^{-1}) a été constatée dans les variantes engraisées de N/P 2,00:1,25:1,00 ($>1,0$) (120 kg N, 75 kg P_2O_5 et 60 kg K_2O) et N/P 2,00:2,00:1,00 (1,0) (120 kg N, 120 kg P_2O_5 et 60 kg K_2O) en rapport avec la recommandation de l'UPN de Dharwad de 1,00:1,25:1,00 ($<1,00$) (60 kg N, 75 kg P_2O_5 et 60 kg K_2O).