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Some Aspects of NPK Nutrition for Improved Yield and Oil Contents of Canola

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Abstract: An experiment was conducted to evaluate the effect of NPK on canola (cv. Dunkeld). Sole dose of N proved superior to split dose and produced significantly taller plants. Nitrogen application methods had no influence on grain yield and oil contents. Grain yield increased with increase in P level. Oil contents significantly increased by P up to 50 kg ha^{-1}, but further increase in P decreased the oil contents. Potassium showed no influence on any observation other than oil contents. A combination of 100 kg N, 75 kg P and 30 kg K ha^{-1} seems to be the optimum dose in terms of higher canola grain production. While highest oil contents can be obtained with 100 kg N, 50 kg P and 60 kg K ha^{-1}.

Key words: NPK, grain yield, oil content, canola

Introduction

Nutrient management of the soil on sustainable basis includes fertilizer types, amounts, time and methods of their application. Proper amount and time of fertilizer application is considered a key to the bumper crop (Jan and Khan, 2000). Nitrogen is also considered a major element of fertilizer for good yield. Nitrogen is closely linked to control the vegetative growth of plant and hence determine the fate of reproductive cycle (Wojnowska *et al.*, 1995). Phosphorus is required in small amount than N for plant growth but is equally important for crop growth (Chen *et al.*, 1994). Potassium is also required in large amount by oil seed crop (Singh *et al.*, 1997). The scope for greater hectarage is limited due to competition with other crops like wheat, sugar beet, fodder and pulses. Therefore, it is suggested that instead of increasing area under oil seed the yield per hectare must be improved. Higher yield per unit area can be achieved by adopting modern cultural practices with better nutrient management. Nitrogen is a major limiting element of plant growth because of its vulnerability to losses (Henry, 1978).

The objective of the study was to find the best method of N application (sole or split) and optimum levels of P and K for higher grain yield of canola.

Materials and Methods

To study 'some aspects of NPK nutrition for improved yield and oil content of canola' an experiment was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar during 1999-2000. Treatments were consisted of two methods of N application (sole and split dose), four levels of P and two levels of K. Details of the experiment are given in Table 1. The experiment was laid out in Randomized Complete Block (RCB). A net size of 4 x 3.5 m^2 was used for each experimental plot having 8 rows of each 50 cm apart and 3.5 m long. Plant to plant distance was maintained at 10 cm. Urea was used as N source while triple super phosphate (TSP) as P and KCl as K source. The crop was sown on October 13th, 1999 with a seed rate of 5 kg ha^{-1} on a well-prepared field. Plant height was recorded on 10 randomly selected plants from each plot. The plant height was measured from soil surface to the top of plant at maturity, and average height was calculated for each treatment. To obtained the grain yield, six central rows were harvested from each treatment. The harvested materials were air dried, threshed and weighed. The grain yield of each plot was converted by a calculated conversion factor to kg ha^{-1}. Oil content (%) was determined by taking 100 g cleaned seeds from each treatment, which were crushed and oil was extracted by soxlet method.

The obtained data was statistically analyzed according to the appropriate method. F-test was employed to detect the significance of treatments effect and LSD was used for mean comparison.

Table 1: Experimental treatment showing all possible combination of NPK (kg ha^{-1})

Treatments	N	P_2O_5	KCl
$N_1P_0K_1$	100[1]	0	30
$N_1P_0K_2$	100	0	60
$N_1P_1K_1$	100	25	30
$N_1P_1K_2$	100	25	60
$N_1P_2K_1$	100	50	30
$N_1P_2K_2$	100	50	60
$N_1P_3K_1$	100	75	30
$N_1P_3K_2$	100	75	60
$N_2P_0K_1$	50 + 50[2]	0	30
$N_2P_0K_2$	50 + 50	0	60
$N_2P_1K_1$	50 + 50	25	30
$N_2P_1K_2$	50 + 50	25	60
$N_2P_2K_1$	50 + 50	50	30
$N_2P_2K_2$	50 + 50	50	60
$N_2P_3K_1$	50 + 50	75	30
$N_2P_3K_2$	50 + 50	75	60

1 = Full dose at sowing time (100 kg ha^{-1})
2 = half dose at sowing + half at rosette stage* (50 kg ha^{-1} each)
* = Rosette : A cluster of spreading or radiating basal leaves (Darrel and Donald, 1980).

Results

The combine effect of different NPK treatments was significant for plant height (Table 2). The planned mean comparison showed that neither dose of phosphorus and potassium had any significant influence on plant height. Different methods of nitrogen application significantly affected plant height. Taller plants were observed in those plots where a sole dose of 100 kg N ha^{-1} was applied at sowing compared to split dose of 50 kg N ha^{-1} at sowing and 50 kg N ha^{-1} at rosette stage. Sole application of N promoted a plant height up to 155 cm while split applied N treatment produced a 142 cm taller plants.

Grain yield of canola showed significant response to the various combinations of NPK nutrition (Table 3). The planned mean comparison showed that phosphorus is responsible for the variation in yield. While split and sole dose of nitrogen and K had no effect on grain yield. On the average, P treatments had significantly higher (1565 kg ha^{-1}) grain yield than no phosphorus treatment (1449 kg ha^{-1}). Among various levels of P, grain yield significantly increased with increase in P level. The highest P level of 75 kg ha^{-1} produced significantly higher (1642 kg ha^{-1}) grain yield followed by 1570 and 1483 kg ha^{-1} from 50 and 25 kg P ha^{-1} respectively. The mean of grains yield shows that whenever the highest dose of P is applied, a significant increase in grain yield was observed regardless the N application level and time. Similarly no response was observed for K levels.

The statistical analysis showed that oil content was significantly affected by different NPK treatments (Table 4). The planned mean comparison showed that the overall significant effect on oil content in the combination of treatments were because of

Table 2: Effect of different NPK levels on the plant height of canola

		Planned means comparison with statistical significance			
Treatments NPK (kg ha^{-1})	Plant height (cm)	Treatments NPK (kg ha^{-1})	Plant height (cm)	Contrast #	
$N_1P_0K_1$	163	N_1 100	155	Full vs. Split	**
$N_1P_0K_2$	142	N_2 50+50	142		
$N_1P_1K_1$	161				
$N_1P_1K_2$	156	No P	147	No P vs. P	ns
$N_1P_2K_1$	149	P	149		
$N_1P_2K_2$	155				
$N_1P_3K_1$	156	P_1 25	149	P Linear	ns
$N_1P_3K_2$	157	P_2 50	148	P Quadratic	ns
$N_2P_0K_1$	143	P_3 75	151		
$N_2P_0K_2$	141				
$N_2P_1K_1$	144	K_1 30	149	K_1 vs. K_2	ns
$N_2P_1K_2$	135	K_2 60	148		
$N_2P_2K_1$	135				
$N_2P_2K_2$	152	Interactions			
$N_2P_3K_1$	139	N X P			ns
$N_2P_3K_2$	150	N x K			ns
		P x K			ns
LSD (0.05)	17.80	N x P x K			ns

Table 3: Effect of different NPK levels on the grain yield of canola

		Planned means comparison with statistical significance			
Treatments NPK (kg ha^{-1})	Yield (kg ha^{-1})	Treatments NPK (kg ha^{-1})	Yield (kg ha^{-1})	Contrast #	
$N_1P_0K_1$	1453	N_1 100	1538	Full vs. Split	ns
$N_1P_0K_2$	1450	N_2 50+50	1534		
$N_1P_1K_1$	1484				
$N_1P_1K_2$	1487	No P	1449	No P vs. P	**
$N_1P_2K_1$	1570	P	1565		
$N_1P_2K_2$	1570				
$N_1P_3K_1$	1641	P_1 25	1483	P Linear	**
$N_1P_3K_2$	1649	P_2 50	1570	P Quadratic	ns
$N_2P_0K_1$	1451	P_3 75	1642		
$N_2P_0K_2$	1442				
$N_2P_1K_1$	1478	K_1 30	1536	K_1 vs. K_2	ns
$N_2P_1K_2$	1485	K_2 60	1536		
$N_2P_2K_1$	1563				
$N_2P_2K_2$	1579	Interactions			
$N_2P_3K_1$	1649	N X P	ns		
$N_2P_3K_2$	1630	N x K	ns		
		P x K	ns		
LSD (0.05)	47.74	N x P x K	ns		

= Contrasts followed by ** are significant at P 0.01 ns = not significant

N_1 = 100 kg ha^{-1} at sowing; N_2 = 50 kg N ha^{-1} at sowing + 50 kg N ha^{-1} at rosette stage; P_0 = No P

P_1 = 25 kg P ha^{-1} at sowing; P_2 = 50 kg P ha^{-1} at sowing; P_3 = 75 kg P ha^{-1} at sowing

K_1 = 30 kg K ha^{-1} at sowing; K_2 = 60 kg K ha^{-1} at sowing

phosphorus. Phosphorus showed a quadratic trend for oil contents. The oil contents increased from 45.25 to 46.35 % for the plots treated with 25 and 50 kg P ha^{-1}, respectively, while further increase in P (75 kg ha^{-1}) decreased the oil content (45.50 %). Similarly, increase in K significantly increased oil content. The oil content increased from 45.36 to 45.84 % with increase in potassium from 30 to 60 kg ha^{-1}. Phosphorus had significant interaction for oil contents when applied in any combination with N and K. The mean of oil content showed that sole dose of N when applied with 50 kg P ha^{-1} increased the oil content up to 46.9 %, but excluding P significantly decreased oil content (44.8 %) with the same treatment of N. Similarly when 50 kg P ha^{-1} combined with the highest dose (60 kg ha^{-1}) of K, achieved highest oil contents (46.5 %). Among the different combination of NPK, 100 kg N, 50 kg P and 60 kg K ha^{-1} at sowing produced the highest oil contents. Lowest oil content (44.6 %) was recorded when no P and 30 kg K ha^{-1} were combined with a sole applied dose of 100 kg N ha^{-1}.

Discussion

Plant height is a function of genetic as well as environmental combinations. It is considered as vegetative growth potential of a crop. Phosphorus and K had no influence on plant height. While N application methods significantly affected plant height. Among various combination of NPK, it seems that N plays a vital role for plant height. The sole dose of 100 kg N ha^{-1} at sowing time produced significantly taller plants compared to split applications. According to Xing *et al.* (1998) canola absorbs most of N at early stage for maximum growth and development subject to availability . An optimum dose of N at early growth stage might increase cell formation, cell division and cell enlargement, resulted in greater leaf area. These functions have greater influence on photosynthetic activities, which ultimately increase crop growth (Holmes, 1980). The combine NPK also increased plant height. The grain yield linearly increased with increase in P levels. Jain *et al.* (1995) and Jahan *et al.* (1992) stated that increase in P levels increase the uptake and utilization of N and K as well as dry matter production. Phosphorus regulates photosynthesis and carbohydrate metabolism and is considered as one of the major growth limiting factor particularly during the reproductive stage. Marchner (1986) and Giaquinta and Quebedeaur (1980) stated that at reproductive stage, P regulate the partitioning of photosynthate between the source and reproductive organs. These findings justify the greater grain yield by higher P levels.

Some researchers Singh *et al.* (1984) and Dixit and Gautam (1996) gave the credit of increase grain yield to the increase level of NPK.

Table 4: Effect of different NPK levels on the oil content of canola

Treatments NPK (kg ha^{-1})	Oil %	Planned means comparison with statistical significance: Treatments NPK (kg ha^{-1})	Oil %	Contrast #	
$N_1P_0K_1$	44.61	N_1 100	45.49	Full vs. Split	ns
$N_1P_0K_2$	45.04	N_2 50+50	45.71		
$N_1P_1K_1$	44.63				
$N_1P_1K_2$	45.54	No P	45.29	No P vs. P	**
$N_1P_2K_1$	46.31	P	45.70		
$N_1P_2K_2$	47.46				
$N_1P_3K_1$	45.11	P_1 25	45.25	P Linear	ns
$N_1P_3K_2$	45.21	P_2 50	46.35	P Quadratic	**
$N_2P_0K_1$	45.60	P_3 75	45.50		
$N_2P_0K_2$	45.92				
$N_2P_1K_1$	44.66	K_1 30	45.36	K_1 vs K_2	**
$N_2P_1K_2$	46.18	K_2 60	45.84		
$N_2P_2K_1$	46.11				
$N_2P_2K_2$	45.52	Interactions			
$N_2P_3K_1$	45.82	N X P			**
$N_2P_3K_2$	45.87	N x K			ns
		P x K			*
LSD (0.05)	00.80	N x P x K			*

= Contrasts followed by *, ** are significant at P 0.05 and 0.01 ns = not significant
N_1 = 100 kg ha^{-1} at sowing N_2 = 50 kg N ha^{-1} at sowing + 50 kg N ha^{-1} at rosette stage P_0 = No P
P_1 = 25 kg P ha^{-1} at sowing P_2 = 50 kg P ha^{-1} at sowing P_3 = 75 kg P ha^{-1} at sowing
K_1 = 30 kg K ha^{-1} at sowing K_2 = 60 kg K ha^{-1} at sowing

Oil content is typically characteristic of species, varieties and their genetic makeup. Nitrogen application methods had no effect on oil content while P and K significantly influenced the oil content of canola. Nitrogen in combination with P and K also affected the oil content. A dose of 50 kg P ha^{-1} produced significantly more oil content compared to 25 and 75 kg P ha^{-1}. It seems that 50 kg P ha^{-1} is an optimum level for canola in term of oil content. According to Holmes (1980) both deficiency and higher levels of P decrease the oil content in rapeseed. However, Trivedi *et al.* (1995) reported that increase in P levels improve oil content of canola. Potassium plays a major role in the enzymatic system that control metabolism of photosynthate and their conversion to oil, (Holmes, 1980). Similarly, Singh *et al.* (1997) concluded form their studies that increase in K levels increases the oil percentage of canola. According to Thakral *et al.* (1996) N and P increases oil content. The combine effect of NPK on oil content was also significant. According to the findings of Puri *et al.* (1999) the combine NPK improved the oil content of canola, they recommended 100: 40: 20 NPK kg ha^{-1} as optimum doses for higher yield and percentage of oil.

Results showed that P & K play a vital role in promoting grain yield and oil contents of canola. A combination of 100-50-30 NPK kg ha^{-1} are recommended for higher grain yield while 100-50-60 NPK kg ha^{-1} increase oil content.

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