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Effect of Different NPK Levels on the Growth and Yield of Kohlrabi (*Brassica caulorapa* L.) at Northern Areas of Pakistan

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Abstract: Effect of seven different NPK levels on the growth and yield of Kohlrabi was investigated. Nitrogen, phosphorus and potassium were applied alone as well as in various combinations and had a significant effect on various plant growth and yield parameters. Maximum tuber weight (430.80 g) tuber diameter (10.23 cm), number of leaves per plant (14.38) and tuber yield (25850 kg ha^{-1}) was recorded in plots fertilized with 160-120-160 kg NPK ha^{-1}. It can be concluded that NPK @ 160-120-60 kg ha^{-1} was found to be the best fertilizer dose for the higher yield of Kohlrabi.

Key words: Kohlrabi, NPK, fertilizer, growth, yield, Northern Areas, Pakistan

Introduction

The climate of Northern Areas of Pakistan is basically a dry continental Mediterranean. But there is a significant variation in temperature and precipitation imposed by altitude and topography (Walter *et al*., 1975). The average irrigated area per house hold is in the range of 15-20 kanals (0.75-1.0 ha) in double cropping area and 30-40 kanals (1.5-2.0 ha) in single crop area, with 20% of this area is under trees and fodder crops leaving approximately 0.075 to 0.15 ha for staple food and vegetable crops per head of population respectively in double and single cropping areas (Whitman, 1985). At present rate of increase, the population will be double in 30 years time and so yield will have to correspondingly doubled just to maintain the present level of food availability. Wise use of expanded irrigation, selection of varieties that fit into optimum cropping system and a judicious and balanced use of fertilizer can help to bridge the forthcoming gap (Whiteman, 1985).

Kohlrabi (*Brassica caulorapa* L.) belongs to family Cruciferae and is closely related to cabbage. It is an excellent vegetable if it is used before it becomes tough and fibrous. It is high in minerals and vitamins A and C. The leaves may be cooked in various ways (Baloch, 1994). Plants require food for growth and development in the form of proper doses of NPK. Nitrogen is a part of chlorophyll molecule, amino acid, proteins, nucleic acid and pigments. Adequate supply of nitrogen favours the transformation of carbohydrates into proteins and promotes the formation of protoplasm and since protoplasm is highly hydrated, the plant becomes more succulent. Normal metabolic activities can continue only in the presence of optimum level of nitrogen. The addition of nitrogen enhances vegetative growth and its deficiency leads to stunted growth with small yellow leaves and low production. (Haque and Jakhro, 1996). Phosphorus plays a vital role in several key physiological processes, viz. photosynthesis, respiration, energy storage and transfer, cell division and cell enlargement. Phosphorus is an important structural component of many biochemical's viz. nucleic acids (DNA, RNA) co-enzymes, nucleotides, phospholipids and sugar phosphate. It stimulates root growth, blooming, fruit setting and seed formation (Memon, 1996). Potassium is considered essential in photosynthesis, sugar translocation, nitrogen metabolism, enzyme activation, stomatal opening, water relation and growth of meristematic tissues, it acts as chemical traffic policeman, root booster, stalk strengthener, protein builder, breathing regulator and retard the diseases, but it is not effective without its co-efficient such as N and P (Chandra, 1989). The actual yield of Kohlrabi is very low against the potential yield. This big gap between the actual and potential yield can be bridged up by adopting modern agronomic techniques like planting methods, use of fungicides, controlled irrigation and increased nutritional status of the soil. The available literature regarding the fertilizer response indicates that NPK application to Kohlrabi improved the yield considerably. Sommer (1992) applied ammonium nitrate either in split applications of top-dressing or according to the cultan system to spinach, kohlrabi, lettuce, endives and beet roots. It was found that cultan system gave similar yields to top-dressing, while reducing the amount of N applied by 20-30%. Sharof and Weir (1994) studied the minimum amount of N required for vegetable crops including kohlrabi in relation to components of N balance in the soil and calculated that N requirement values were invariably lower than values from field trials. Fink (1995) revealed that previous crop residues could affect the nitrogen requirements of kohlrabi. According to him nitrogen fertilizer dose can be reduced by up to 100 kg N ha^{-1} without affecting yield when whole crop (lettuce) has had

to ploughed in. Gianguinlo and Borin (1996) reported that the stem size and homogeneity for kohlrabi crop were best grown in peaty-clay soil with 100 kg N+50 kg P_2O_5 kg +104 kg K_20 ha^{-1} as mineral fertilizer. Clay soil also proved to be suitable for this crop when mineral fertilizer + farmyard manure was used. Chaltoo *et al.* (1997) applied N fertilizer at 0, 25, 50, 75 or 100% of the recommended rate and reported that kohlrabi yield increased as N rate increased. Filler and Fink (1997) conducted experiment on the nitrogen uptake of kohlrabi estimated by growth stages and an empirical growth. They reported that estimation by applying an empirical N uptake were more complicated while using observed growth stages resulted in the smallest estimation error. Fisher (1997) applied varying amounts of N (applied as NH_4NO_3) and K (applied as 50:50 KCl:K_2 SO_4) along with P, Fe, Mn and Zn. It was concluded that changes in the aroma of Kohlrabi after increased fertilizer inputs were due to alkylisothiocyanates with their low threshold values and specific odour qualities. Schlereth *et al.* (1998) applied 110,135 or 160 kg N ha^{-1} to kohlrabi using the cultan system (controled up take long term ammonium nutrition) and reported that average tuber diameter was about 80 mm and was not significantly affected by N amount or source. The present study was conducted to find a suitable dose of fertilizer for the high yield of kohlrabi.

Materials and Methods

This study was conducted at Karakuram Agricultural Research Institute for Northern Areas, Juglote, Gilgit during 2001-2002. The experiment was laid out in randomized complete block (RCB) design. Variety used was white vienna. Healthy seedlings of equal size were transplanted keeping the row–row and plant-plant distances as 40 and 20 cm respectively. Plot size was 10 m^2 and total area under cultivation was 280 m^2. Before conducting the experiment soil samples were taken and analyzed at Agricultural Research Station Mingora, Swat. The physico-chemical characteristics, detail of treatments of experimental field are given in Table 1 and 2 respectively.

Nitrogen was applied in two split doses. First dose of N along with full doses of phosphorus and potassium was applied at the time of transplantation, while the remaining half dose of nitrogen was given at tuber formation stage. Irrigation and other cultural practices such as weeding, hoeing and sprays against insects, pests and disease were done uniformly in all treatments of each replication. The data were recorded on tuber weight (g) tuber diameter (cm) number of leaves per plant and tuber yield (kg ha^{-1}). The data thus collected were analyzed using analysis of variance techniques and Duncan's new multiple rang test at 5% probability level was applied to test the significance of treatments means (Steel and Torrie, 1984).

Table 1: Physicochemical properties of soil

Parameters	values
Textural class	Sandy Loam
Lime content	6.250 %
Organic matter	0.774 %
Nitrogen	0.39 %
P_2O_5	143.26 mg kg^{-1}
K_2O	95.60 mg kg^{-1}
pH	6.0

Table 2: Detail of treatments in experimental field

	Levels of fertilizer (kg ha^{-1})		
Treatments	N	P	K
T1	0	0	60
T2	120	0	0
T3	0	120	0
T4	160	0	60
T5	0	120	60
T6	160	120	0
T7	160	120	60

Results and Discussion

Tuber weight (g): NPK in different combinations had a significant effect on tuber weight while the NPK applied in alone form had no significant differences (Table 3). Maximum tuber weight (430.80 g) was obtained with a fertilizer level of 160-120-60 kg ha^{-1} of NPK, while minimum tuber weight (235.78 g) was recorded in plots receiving only potassium @ of 60 kg ha^{-1}. The maximum tuber weight might be due to balanced fertilization because normal metabolic processes can continue only in the presence of an optimum level of nitrogen and phosphorus and potassium plays its role in the promotion of growth and meristematic tissues. As the soils that are high in clay usually are high in available potash (Thompsom and Kelly, 1982) but the soil of experimental field had a sandy textural class therefore the application of potassium along with nitrogen and phosphorus resulted in the increase of tuber weight.

Tuber diameter (cm): NPK fertilizer applied alone or in different combinations significantly affected the tuber diameter. Maximum tuber diameter (10.23 cm) was noted at fertilizer level of 160-120-60 kg ha^{-1} of NPK (Table 3). This may be due to the fact that the presence of all the three major elements in a suitable combination enhanced the vegetative growth of the plants. The plants growing in this treatment had maximum number of leaves (14.38) that might have enhanced the photosynthetic activities and prepared sufficient food for the plant growth and tuber enlargement. But these results do not agree with the findings of Schlereth *et al.* (1998) who obtained an average tuber diameter of 80 mm and reported that it was not significantly affected by nitrogen amount or source.

Table 3: Effect of NPK fertilizers on the yield of kohlrabi

Treatments NPK (kg ha^{-1})	Tuber weight (g)	Tuber diameter (cm)	Number of leaves per plant	Tuber yield (kg ha^{-1})
0-0-60	235.78c	6.27d	9.42c	14140.50c
120-0-0	271.35c	8.725c	12.50ab	16270.20c
0-120-0	239.80	7.17cd	10.77bc	14389.50c
160-0-60	325.90bc	9.35ab	14.23a	19550.50bc
0-120-60	254.20c	7.85bd	12.13ab	15250.40c
160-120-0	398.30ab	9.67ab	14.03a	23900.0ab
160-120-60	430.80a	10.23a	14.38a	25850.0a
LSD	95.67	1.90	2.55	5740.0

Means followed by same letter (s) in column do not differ significantly using LSD test at 5% level of probability.

Number of leave per plant: Number of leaves was significantly affected by different NPK levels (Table 3). Maximum number of leaves (14.38) was recorded at fertilizer level of 160-120-60 kg NPK ha^{-1} while minimum number of leaves per plant (9.42) was noted in treatment where only potassium was applied @ 60 kg ha^{-1}. Mineral nutrition had a good effect on the growth of kohlrabi. Nitrogen is an integral part of chlorophyll. It is a constituent of all proteins and promotes vigorous vegetative growth and deep colour, while phosphorus and potassium play a vital role in several key physiological processes viz. photosynthesis, respiration, energy storage, cell division and cell enlargement. Therefore the increased number of leaves per plant may be due to balanced fertilization of the crop.

Tuber yield (kg ha^{-1}): Statistical analysis revealed that different combinations of NPK fertilizers had a significant effect on tuber yield, while non-significant results were obtained when these minerals were applied alone (Table 3). Maximum tuber yield (25850 kg ha^{-1}) was obtained at fertilizer level of 160-120-60 kg NPK ha^{-1}. The increase in tuber yields might be attributed to increase in tuber weight and tuber diameter in this treatment. As the soil was low in nitrogen, available phosphorus and potassium, therefore, the balanced amount of fertilizers resulted in higher yield of the crop. The results are in close conformity with those of Chaltoo *et al.* (1997) who reported that kohlrabi yield increased as N rate increased.

In conclusion, combination of nitrogen, phosphorus and potassium @ 160-120-60 kg ha^{-1} was found to be the best dose of fertilizer and is recommended for the highest yield of kohlrabi under the agro-climatic conditions of Gilgit, Northern Areas, Pakistan.

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