NUTRIENT UPTAKE OF SOME OKRA VARIETIES AS INFLUENCED BY DIFFERENT LEVELS OF APPLIED N, P AND K

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ABSTRACT: *An experiment was conducted to investigate the nutrient uptake of some okra varieties (i.e. Bemisal, Sabzpari and Reshum) as affected by different levels of applied N, P and K corresponding to 0-0-0, 25-25-25, 50-25-25, 75-37-37, 100-50-50, 125-62-62 and 150-75-75 kg ha^{-1} at Sindh Agriculture University Tandojam, Pakistan. On average, the maximum uptake of N (76.62kg ha^{-1}), P (38.54 kg ha^{-1}) and K (48.68 kg ha^{-1}) was observed at the highest levels of NPK 150-75-75 kg ha^{-1}. Decreasing the levels of NPK from 125-62-62, 100-50-50, 75-37-37, 50-25-25 and 25-25-25 kg ha^{-1} resulted in reduction in N uptake from 73.91, 66.69, 63.24, 52.69 and 38.24 kg; P uptake from 33.81, 26.99, 23.03, 20.32 and 19.16 kg and K uptake from 43.80, 38.83, 31.51, 25.47 and 23.45 kg ha^{-1}, respectively. The lowest N, P and K uptake was recorded in control, where no NPK fertilizers were applied. It was also observed that K uptake increased with the increase in P levels. Among the tested okra varieties, Sabz Pari got maximum uptake of NPK (56.73, 25.01 and 32.67 kg ha^{-1}) compared to Bemisal and Reshum.*

Keywords: Okra, varieties, NPK, plant nutrient uptake

INTRODUCTION

Inefficient use of fertilizers is the major factor to constrain desired crop production and nutrients inputs at optimum rates are required to overcome this constraint. The use of greater amount of fertilizer not only increases cost of inputs but also creates soil and environment pollution. Amjad [1] reported that the application of macronutrient NPK fertilizer gives 67% yield increase over control. The application of adequate fertilizers tends to increase crop yields with improved nutrient element concentrations in plant tissue and improved soil macro and micronutrient status [2]. The deficiency of Zn is likely to occur in semi arid light texture soils under intensive cropping [3].

Among macronutrients, nitrogen (N), phosphorus (P) and potassium (K) are essential elements required by the plants for their growth and vigour. Nitrogen is considered as an essential element of bio-molecules such as amino acids, proteins, nucleic acids, phytohormones and a number of enzymes and coenzymes [4]. N strongly stimulates growth, expansion of the crop canopy and interception of solar radiation [5]. Similarly, P is also an essential nutrient element both as a part of several key plant structure compounds and as a catalysis in the conversion of various biochemical reactions in plants. P stimulates root development, increase stem strength, improve flower formation and seed production, more uniform and earlier crop maturity, improvements in crop quality, and increased resistance to plant diseases [6]. Similarly, K is one of sixteen essential nutrient elements required for plant growth and reproduction. K is classified as a macronutrient and defined as K_2O, used to express the content of various fertilizer materials containing potassium. Itons has a vital role in photosynthesis, translocation of photosynthates, protein synthesis, regulation of plant stomata, activation of plant enzymes and many other processes.

The fertility requirements for okra in regard to N, P, and K rates and ratios have not been extensively studied. Apart from the agronomic performance of the crop, the uptake of okra plants was 21, 62 and 46 kg of N, P_2O_5 and K_2O, respectively for achieving 11.5 tons pod yield. This indicates that okra may not respond to as high a rate of N, P and K as some other vegetable crops [6]. Recommended rates of NPK for okra appear to vary greatly depending on cultivars, climatic conditions and soil types and Ahmadu [7], recommended 112 kg N ha^{-1} for maximum okra yield and higher plant nutrient uptake. They found that plant nutrient uptake was dose dependent from these particular nutrients. Other recommendations included 135 kg ha^{-1} [8] depending on cultivar and observed that the optimum rate of N for okra plant dry matter production and plant N uptake (100 kg N ha^{-1}), was higher than that for maximum edible fruit yield and for enhanced okra pod production. Bandyopadhyay [9] reported that okra cv. Parbhani Kranti plants gave highest yield with 50:25:25 kg NPK ha^{-1}. Gowda [10] reported that NPK at the rate of 175:125:100 kg ha^{-1} resulted in maximum fruit yield and nutrient uptakes significantly affected by increasing NPK. Pant [11] reported that NPK at the rate of 80:40:30 kg ha^{-1} gave the highest pod yields corresponding to higher nutrient uptakes; while Gowda [10] found that 150:100:75 kg NPK ha^{-1} produced positive results in terms of pod production of all varieties coupled with plant nutrient contents and uptakes. Aslam [12] reported that 150 kg N along with 75 kg P and 25 kg K combination produced higher pod yields in okra and plant nutrient contents.

Crop uptake of nutrients is affected by soil and climatic conditions. Low soil moisture, poor aeration due to compaction or excessive moisture, low soil temperatures, high lime in the root zone, nutrient imbalances, and other factors may restrict uptake of plant nutrients. However, the plant nutrient uptake under conditions of low soil fertility depends on the application of nutrients. The agriculture soils of Sindh province have become severely deficient of macro and micro-elements that are essentially required for growth and development of the plants. Due to inadequacy of these soil nutrients, the crops yield poorly and the farmers are economically deprived. Therefore, the experiment was conducted to investigate the plant nutrient uptake in okra varieties as affected by soil applied nutrients.

MATERIALS AND METHODS

An experiment was conducted to investigate the impact of different levels of applied N, P and K on nutrient uptake of some Okra varieties under semi arid climate, located at 25°25' 60'N 68°31' 60E and 19.5 m above the sea level. Three okra varieties (Bemisal, Sabz pari and Reshum) were used against different NPK levels against various levels of NPK (0-0-0, 25-25-25, 50-25-25, 75-37-37, 100-50-50, 125-62-62 and 150-75-75 kg ha^{-1}). The sowing was done with single coulter hand driven drill in the month of February 2009 and 2010 in rows (60 cm spacing). The crop was kept free of weeds by giving one hoeing with spade before the 1st irrigation. All the cultural practices including plant protection measure were adopted uniformly in all the plots to maintain the experimental area.

Soil type

The soils of Sindh mostly are similar to the soil type of the experimental site; this is referred to as "atypical". Moreover, the popular commercially okra growing areas of Sindh province have similarity to the soil of experimental site. The experimental soil was clay loam in texture. Table 1 revealed that the chemical properties of soil before sowing and after harvesting during both years (2009 and 2010) under experiment field. The EC (dSm^{-1}) of soil, pH of soil, Organic matter and Exchangeable Potassium in the field were decreaed after harvesting under both years. Similarly, Total Nitrogen and Available Phosphorous were increased after harvesting under expriment.

Table 1. Chemical properties of the soil before sowing and after harvesting

Parameters	2009		2010	
	Before sowing	After harvesting	Before sowing	After harvesting
EC (dSm^{-1})	4.42	4.01	4.23	4.11
pH	7.50	7.30	7.30	7.10
Organic matter (%)	0.596	0.385	0.309	0.298
Total Nitrogen (%)	0.026	0.033	0.029	0.035
Available Phosphorous (mg kg^{-1})	4.376	4.453	3.877	4.287
Exchangeable Potassium (mg kg^{-1})	128.32	118.11	134.33	115.12

Cultural Practices

Land was prepared properly at required depth for better root penetration and for equal distribution of irrigation and fertilizer. Pure seed of different okra verities was used. The seed was sowing on ridges at distance of 60 cm between rows and 30 cm plants. The soil was kept with enough moisture to facilitate better germination. The crop was irrigated at an interval of 5-6 days in summer. Four hoeing at 3, 6, 9 and 12 weeks interval was preferred to keep weed under control. The tender young pods were harvested every alternate day. This caused to promote fruit development and yield.

Data gathered method of determinations

Nutrient uptake: Nutrient uptake was calculated on the basis of nutrient measured in plants (plant + seed) multiply by yield in kg ha^{-1} and then divided by 100.

Nitrogen (%): By Kjedahl method as described in soil chemical analysis method no. 8-4, P. 183. samples were analyzed at soil science Laboratory, Department of Soil Science, S.A.U Tandojam.

Phosphorus (%): By acid wet digestion method, ($HClO_4$ / HNO_3) method using by spectrophotometer. Samples were analyzed at soil science Laboratory, Department of Soil Science, S.A.U Tandojam.

Potassium: By acid wet digestion method ($HClO_4$ / HNO_3) method using EEL Flame photometer. Samples were analyzed at soil science Laboratory, Department of Soil Science, S.A.U Tandojam.

Zn (mg kg^{-1}): By AB-DTPA method, using automatic absorption spectro photometerically. Samples were analyzed at soil science Laboratory, Department of Soil Science, S.A.U Tandojam.

Statistical analysis

The data thus collected were subjected to statistical analysis using MSTAT-C, 1983 computer software (Gomez and Gomez, 1984). The difference among the treatment means were compared by the least significant difference (LSD) test.

RESULTS AND DISCUSSIONS

Effect of different NPK levels on Plant N uptake (kg ha^{-1}) of okra

The N uptake by the plants was significantly ($P<0.05$) affected by different levels of soil applied NPK, while okra varieties also differ significantly ($P<0.05$) for N uptake. On average, the N uptake of okra plants was highest (76.62 kg ha^{-1}) under highest NPK level of 150-75-75 kg ha^{-1}, while plant N uptake decreased to 73.91, 66.69, 63.24, 52.69 and 38.24 kg ha^{-1} with decreasing NPK application to 125-62-62, 100-50-50, 75-37-37, 50-25-25 and 25-25-25 kg ha^{-1}, respectively. The lowest N uptake (21.98 kg ha^{-1}) was determined in control, where no NPK were applied. This indicates that the N uptake was directly proportional to soil application of N as well as fruit yield of the test crop. In case of varieties, Sabzpari remained most efficient to N uptake (56.73 kg ha^{-1}), followed by Bemisal (56.16 kg ha^{-1}) and lowest by variety Reshum (55.69 kg ha^{-1}). The interactive effects showed that the N uptake was highest (77.39 kg ha^{-1}) in the variety interaction (Sabzpari*NPK) under 150-75-75 kg ha^{-1}, and lowest (21.75 kg ha^{-1}) in the variety interaction (Reshum*NPK) in control treatment and values are presented in the Table 2.

Table 2. Effect of different NPK levels on Plant N uptake (kg ha^{-1}) of okra

NPK levels (kg ha^{-1})	Bemisal	Sabzpari	Reshum	Mean
F1=0-0-0	21.97	22.22	21.75	21.98 g
F2= 25-25-25	38.02	38.40	38.30	38.24 f
F3= 50-25-25	52.69	53.22	52.16	52.69 e
F4= 75-37-37	63.24	63.88	62.61	63.24 d
F5= 100-50-50	66.69	67.36	66.02	66.69 c
F6= 125-62-62	73.91	74.66	73.17	73.91 b
F7= 150-75-75	76.62	77.39	75.86	76.62 a
Mean	**56.16 b**	**56.73 a**	**55.69 c**	-

Statistical analysis

Factors	NPK levels (N)	Varieties (V)	N*V
S.E.±	0.3900	0.2553	0.6755
LSD 0.05	0.7883	0.5160	1.3653
F-Value	3594.66	5.67	2.158
P-Value	0.0010	0.0000	0.0438

Table 3. Effect of different NPK levels on P uptake (kg ha^{-1}) of okra

NPK levels (kg ha^{-1})	Bemisal	Sabzpari	Reshum	Mean
F1=0-0-0	10.63	10.93	10.62	10.72 g
F2= 25-25-25	19.00	19.51	18.97	19.16 f
F3= 50-25-25	20.00	20.85	20.12	20.32 e
F4= 75-37-37	23.27	23.26	22.79	23.03 d
F5= 100-50-50	26.79	27.46	26.72	26.99 c
F6= 125-62-62	33.61	34.35	33.46	33.81 b
F7= 150-75-75	38.74	38.72	38.15	38.54 a
Mean	**24.57 b**	**25.01 a**	**24.41 b**	-

Statistical analysis

Factors	NPK levels (N)	Varieties (V)	N*V
S.E.±	0.3293	0.2840	0.7436
LSD 0.05	0.8677	0.5680	1.5029
F-Value	791.225	1.290	1.303
P-Value	0.0048	0.0000	0.2238

Table 4. Effect of different NPK levels on K uptake (kg ha^{-1}) of okra

NPK levels (kg ha^{-1})	Bemisal	Sabzpari	Reshum	Mean
F1=0-0-0	14.61	14.95	14.56	14.71 g
F2= 25-25-25	23.35	23.78	23.21	23.45 f
F3= 50-25-25	25.37	25.83	25.22	25.47 e
F4= 75-37-37	31.41	31.92	31.19	31.51 d
F5= 100-50-50	38.73	39.32	38.44	38.83 c
F6= 125-62-62	43.70	44.34	43.96	43.80 b
F7= 150-75-75	48.58	49.27	48.20	48.68 a
Mean	**32.25 a**	**32.77 a**	**32.03 b**	**-**

Statistical analysis

Factors	NPK levels (N)	Varieties (V)	N*V
S.E.±	0.2815	0.1843	0.4876
LSD 0.05	0.5690	0.3725	0.9855
F-Value	3694.27	6.12	3.16
P-Value	0.0048	0.0000	0.0501

Effect of different NPK levels on P uptake (kg ha^{-1}) of okra

The plant P uptake of the okra crop was significantly (P<0.05) influenced by application of different NPK levels, while the differences in plant P uptake of different varieties were statistically non-significant (P>0.05). On average, the P uptake of okra plants was highest (38.54 kg ha^{-1}) under highest NPK level of 150-75-75 kg ha^{-1}, and the plant P uptake reduced to 33.81, 26.99, 23.03, 20.32 and 19.16 kg ha^{-1} with decreasing NPK levels up to 125-62-62, 100-50-50, 75-37-37, 50-25-25 and 25-25-25 kg ha^{-1}, respectively. The lowest P uptake (10.72 kg ha^{-1}) was recorded in control, where no NPK were applied. It was noted that the P uptake was simultaneously increased by increasing P levels. In varieties, the P uptake was slightly higher for Sabzpari (25.01 kg ha^{-1}), followed by Bemisal (24.74 kg ha^{-1}) and lowest by variety Reshum (24.41 kg ha^{-1}).The interactive effects indicated that the P uptake was highest (38.74 kg ha^{-1}) in the variety interaction (Bemisal*NPK) under 150-75-75 kg ha^{-1}, and lowest (10.62 kg ha^{-1}) in the variety interaction (Reshum*NPK) in control practice. The statistical results are presented in the Table 3.

Effect of different NPK levels on K uptake (kg ha^{-1}) of okra

Table 4 illustrates the plant K uptake of okra was significantly (P<0.05) affected by different levels of NPK fertilizers, varieties as well as by their interaction. On average, the plant K uptake of okra was highest (48.68 kg ha^{-1}) under highest NPK level of 150-75-75 kg ha^{-1}, and the plant K uptake reduced to 43.80, 38.83, 31.51, 25.47 and 23.45 kg ha^{-1} with decreasing NPK levels up to 125-62-62, 100-50-50, 75-37-37, 50-25-25 and 25-25-25 kg ha^{-1}, respectively. The lowest plant K uptake (14.71 kg ha^{-1}) was recorded in control, where no NPK fertilizers were applied. It was noted that the plant K uptake was increased with increasing P levels. In varieties, the plant K uptake was higher for Sabzpari (32.67 kg ha^{-1}), closely followed by Bemisal (32.35 kg ha^{-1}) and lowest plant K uptake was observed in variety Reshum (32.03 kg ha^{-1}).The interactive effects showed that the plant K uptake was highest (49.17 kg ha^{-1}) in the variety interaction (Bemisal*NPK) under 150-75-75 kg ha^{-1}, and similarly, lowest (14.56 kg ha^{-1}) in the variety interaction (Reshum*control) in zero NPK applied. New crop varieties are regularly coming in the agricultural markets, and due to fast changing environments the optimization of nutrients has become imperative. Among the tested okra varieties, Sabzpari had outstanding performance over the rest of varieties (Bemisal and Reshum) with total N, P and K uptakes of 56.73, 25.01 and 32.67 kg ha^{-1}. These results are fully supported by Amjad [1] who reported that the pod yield and nutrient uptake were higher in case of okra cv. Sabz pari than the rest of the varieties tested. However, the nutrients uptake was greatly influenced by the rate of NPK application and considered to be dose dependent. Gowda [10] evaluated okra cultivars Arka Anamika, Varsha and Vishal and reported that Varsha had the maximum nutrient uptake, accumulation in leaves and fruits at the higher NPK rates. Sundaram and Kanthaswamy [13] reported highest pod yields and positive physiological response to different fertility levels; similarly, examined okra varieties Pusa Swani, Mirpurkhas-I and Ahmedabadi and reported that Mirpurkhas-I showed its superiority over Ahmedabadi and Pusa Swani in pod yield and nutrient uptakes. Jana [14] examined the performance of different okra varieties and found that okra variety Arka Anamika was most suitable for higher and quality green pod yields from nutrients point of view.

The highest plant uptake of N (76.62 kg), P (38.54 kg) and K (48.68 kg ha^{-1}) was determined when the soil was supplied with highest NPK level of 150-75-75 kg ha^{-1}. Decreasing NPK application to 125-62-62, 100-50-50, 75-37-37, 50-25-25 and 25-25-25 kg ha^{-1} resulted in simultaneous reduction in plant N uptake up to 73.91, 66.69, 63.24, 52.69 and 38.24 kg; P uptake 33.81, 26.99, 23.03, 20.32 and 19.16 kg and plant K uptake 43.80, 38.83, 31.51, 25.47 and 23.45 kg ha^{-1}, respectively. The lowest plant N, P and K uptake was recorded in control, where no NPK fertilizers were applied. It was noted that the plant K uptake was increased with increasing P levels. The above findings are well comparable with the results reported by Ahmadu [7] who recommended 112 kg N ha^{-1} for maximum okra yield and higher plant nutrient uptake. The plant nutrient uptake was dose dependent for these particular nutrients. Mengel and Kirkby [8] argued that nutrient uptakes depend on cultivars as well as the rate of soil applied these nutrients and observed that the optimum rate of N for okra plant dry matter production and plant N uptake (100 kg N ha^{-1}), was higher than that for maximum edible fruit yield and for enhanced okra pod production. Bandyopadhyay [9] reported that okra plants gave highest yield with 50:25:25 kg NPK ha^{-1} as well as the maximum NPK uptakes by the plants; while Gowda [10] reported that NPK at the rate of 175:125:100 kg ha^{-1} resulted in maximum fruit yield and nutrient uptakes significantly affected by increasing NPK. Pant [11] reported that NPK at the rate of 80:40:30 kg ha^{-1} gave the highest pod yields corresponding to higher nutrient uptakes.

CONCLUSIONS

Sabzpari okra variety showed its superiority over other tested varieties (Bemisal and Reshum) with higher values for plant nutrient uptakes. The NPK uptakes increased with increasing soil application rate of these nutrients and found to be highest uptakes when NPK fertilizers were applied at the rate of 150-75-75 kg ha^{-1}.

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