

ROOT INFLUX OF NUTRIENTS AS INFLUENCED BY LEVELS OF POTASSIUM AT VARIOUS GROWTH STAGES OF COTTON CULTIVARS

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ABSTRACT

A pot experiment entitled "Root influx of nutrients and yield of Bt cotton cultivars as influenced by potassium levels" was conducted at the Department of Agricultural Chemistry and Soil Science, College of Agriculture, Junagadh Agricultural University, Junagadh to assess the effect of varieties and levels of potassium on dry matter yield, concentration and root influx of NPK in Bt cotton. The experiment consisting 20 treatment combinations with five Bt cotton varieties approved by Government of Gujarat / India and four levels of K_2O (0, 80, 120 and 160 kg/ha) and replicated thrice for each stage. The result revealed that the concentrations of nitrogen, phosphorus and potassium in shoot, root and in seed cotton did not influenced significantly by varieties of Bt cotton. The concentration of K in the shoot and root at 30, 60, 90 and 120 days increased with increasing levels of potassium application. The concentration of potassium in seed cotton was higher at 160 kg K_2O /ha, whereas the concentration of nitrogen and phosphorus were not influenced by potassium application. The average concentration of nitrogen in shoot and root of Bt cotton was 2.52 and 0.89 per cent at 30 days, 2.32 and 0.84 per cent at 60 days, 1.93 and 0.98 per cent at 90 days and 1.54 and 0.88 per cent at 120 days growth period, respectively. The dry matter yield of shoot, root and total plant at 30, 60, 90 and 120 days were influenced significantly by different varieties viz., Ankur-165, Vikram-5, Shakti-7, Rashi-2 and Mico-162 of Bt cotton. Almost, the dry matter yield of shoot and root parts of plant and total plant dry matter recorded the highest values with a variety V_4 (Rashi-2) followed by Mico-162. The dry weight of all growth parameters increased with increasing levels of potash at all the growth periods. Root influx of nitrogen, phosphorus and potassium as influenced by the varieties of Bt cotton at 30-60 and 90-120 days growth period were recorded higher with variety V_4 (Rashi-2), but remained unaffected at 60-90 DAS. The application of K produced significant effect on root influx of N, P and K at 30-60 DAS and K at 90-120 DAS, while root influx of N, P and K at 60-90 DAS remained unaffected. The root influx of nitrogen, phosphorus and potassium was observed in range of 7.94 – 14.82 ($N \times 10^{-7}$), 1.24 – 3.34 ($P \times 10^{-7}$) and 10.60 – 19.91 ($K \times 10^{-7}$) mg/cm/sec at 30-60, 60-90 and 90-120 days growth period. The root influx of K was recorded maximum at 30-60 days (initial stage) as compared to both later stages (60-90 DAS and 90-120 DAS) of crop.

KEY WORDS: Bt cotton, Potassium, Root influx

INTRODUCTION

Knowledge regarding the relation between the rate of absorption by plant root and the concentration of ion external to the root is important for doing plant nutrient study for investing ion absorption mechanism and for evaluating mechanism of nutrient supply to plant root to the root growing in soil. It is truism that our interest is production of a yield within a given time. The uptake of nutrient is an essential part of growth process and if the uptake rates does not keep place with the growth rate.

The concentration of nutrient in the plant tissue may decrease and plant may become deficient resulting into poor yield. Root and shoot from the absorbing surfaces of plants below and above ground, respectively and the activity of such surfaces can be measured as a mean uptake rate per unit surface of flux. This approach arises from a consideration of the function of roots in soil. This suggest that in soil fertility studies one should not ask whether there are sufficient available nutrients in the soils, but rather ask whether the root system of crop in that soil is able to take nutrients at the rate necessary for maximum growth. Most of this work is formulated in term of uptake of nutrient per unit surface area or flux. However, it follows from the equation for diffusion to a cylinder that root is in fact, mainly determined by the uptake rate per unit length or the root influx (Nye and Tinker, 1969 and Brewster and Tinker, 1970). In the above context, a well planned pot experiment was conducted to study the root influx of nutrients in the Bt cotton cultivars as influenced by different levels of potassium.

MATERIALS AND METHODS

A pot experiment was conducted in soil having characteristics of vertic haplustepts, clayey in texture, calcareous in nature and slightly alkaline in reaction without any problem of salinity with four levels of potassium (0, 80, 120 and 160 kg

K₂O /ha) and five varieties of Bt cotton (V₁: Ankur – 165, V₂: Vikram – 5, V₃: Shakti – 7, V₄: Rashi – 2, and V₅: Mico-162 using eight replication in a Completely Randomized Factorial design. The experimental soil had pH 7.99, EC 0.44 dS/m, O.C. 6.2 per cent and CEC 44.5 cmol (P⁺)/kg soil. The soil contains 295, 32 and 178 N, P₂O₅ and K₂O kg/ha, respectively. Galvanized pots were filled with 40 kg soils. Cotton crop was fertilized with 160 kg N/ha in the form of urea. Nitrogen was applied in split as 50 per cent as basal and remaining 50 per cent as top dressing in two equal split at 30 and 60 days after sowing and potassium was applied in the form of muriate of potash @ 0, 80, 120 and 160 kg/ha. Two seeds of five varieties of Bt cotton were dibbled in each pot to a depth of 5 cm and it was irrigated immediately with tap water. After one week of germination, one healthy plant per pot was maintained.

The chemical studies carried out by taking representative samples of plant and seed from each net plot in all the replications at 60 DAS and harvest. All samples were powdered by mechanical mill grinder. Finally, the powdered samples were utilized for estimation of nitrogen, phosphorus and potassium. The known quantities of powdered samples were digested in a diacid mixture as per method described by Johnson and Ulrich (1969). This acid extract was used for the determination of phosphorus and potassium. The nitrogen from plant samples were estimated separately by micro Kjeldahls method as described by Kanwar and Chopra (1976). The phosphorus determined by Vanadomolybdo phosphoric yellow colour method as described by Jackson (1973). The potassium determine by flame photometer as described by Jackson (1973).

The roots from each pot were separated out from soil by fine jet of water at the different growth periods. The volume of roots was measured by method of water

displacement when roots were immersed in water. The diameter of roots at base, middle and tip was measured by using travelling microscope. The total length of roots was calculated assuming roots as a cylindrical form by using the following formula.

$$V = \pi r^2 h, h = V/\pi r^2$$

Where,

V = Volume of root in cm³,

r = Root radius in mm,

h = Total root length in cm,

$\pi = 3.14$.

The root inflow rate of nutrients was calculated by using following formula given by Brewster and Tinker (1970).

$$I = \frac{(U_2 - U_1) \ln L_2 / L_1}{(t_2 - t_1)(L_2 - L_1)} \quad \text{mg/cm/sec}$$

Where,

I = Nutrient inflow rate (mg/cm/sec),

U1 = Nutrient uptake at time t1,

U2 = Nutrient uptake at time t2,

L1 = Root length at time t1,

L2 = Root length at time t2,

t1 & t2 = Two times of successive harvest.

RESULTS AND DISCUSSION

Dry matter yield

The perusal of data (Table 1) indicated mean and combined effect of variety and potassium on dry weight of growth parameters in *Bt* cotton at 30, 60, 90 and 120 DAS.

Effect of variety:

The dry yield of shoot, root and total plant as 30, 60, 90 and 120 days influenced significantly by different tested varieties viz., Ankur-165, Vikram-5, Shakti-7, Rashi-2 and Mico-162 of *Bt* cotton (Table-1). The dry weight of root, shoot and total plant were recorded the highest with variety V₄ (Rashi-2) with values of 7.16, 0.68 and 7.83 g/plant at 30 DAS, it was also remain at par with varieties V₅ (Mico-162) and V₃ (Shakti-7) for

dry weight of shoot and total plant and V₅ (Mico-162), V₃ (Shakti-7) and V₂ (Vikram-5) for dry weight of root. The dry weight of root, shoot and total plant were recorded 61.46, 6.72 and 68.18 g/plant at 60 DAS and it was also remained at par with V₅ (Mico-162). The dry weight of root, shoot and total plant were recorded 136.86, 21.18 and 158.04 g/plant at 90 DAS, which was remained at par with variety V₅ (Mico-162), V₃ (Shakti-7) and V₂ (Vikram-5). The dry weight of root, shoot and total plant were recorded 282.56, 38.92 and 321.48 g/plant at 120 DAS, respectively as compared to remaining varieties, which was also remained at par with variety V₅ (Mico-162) of *Bt* cotton except root dry matter yield. Almost, the dry yield of shoot and root parts of plant and total plant recorded higher with variety V₄ (Rashi-2). Thus, the dry matter variability is vary due to growth habit of variety of cotton. These results are in agreement with those reported by Mullins and Burmester (1990).

Effect of potassium :

The data furnished in Table 1 indicated that potassium application at various levels significantly influenced the dry weight of shoot, root and total plant, which were recorded higher under 160 kg K₂O /ha followed by 120 kg K₂O /ha at all 30, 60, 90 and 120 DAS, respectively. The sufficient K status of plant tissue positively influence the growth of cotton (Pandey, 1969).

Nutrient content

The data presented in Table 2 and 3 showed indicated effect of variety and potassium on N, P, K content in root and shoot part of plant at various growth stages.

Effect of variety:

The perusal of the data in Table 2 and 3 revealed that the concentration of nitrogen, phosphorus and potassium in shoot and root did not influenced by tested varieties of *Bt* cotton. The results of the present study are in

close conformity with finding of Cassman *et al.*, 1989).

Effect of potassium:

The application of potassium significantly affected on K content in shoot and root parts of plant (Table 2 and 3). Significantly the highest K content (1.61 and 1.68%) in shoot was recorded under application of 120 kg K₂O /ha which was at par with 80 and 160 kg K₂O /ha at 30 and 60 DAS, whereas K content (0.77 %) in root was registered higher at 120 and 160 kg K₂O /ha over that of no K fertilization and it also remained at par with 80 kg K₂O /ha at 30 DAS, while K content in root did not influenced under various rates of potassium application at 60 DAS. The content of potassium recorded the highest values in shoot (1.76%) at 160 kg K₂O /ha and root (1.10%) at 120 kg K₂O /ha over that of remaining doses of potash application. It was also found at par with 80 and 120 kg K₂O /ha for K content in shoot and 160 kg K₂O /ha for K content in root at 90 DAS. Significantly the highest K content was recorded with application of 120 and 160 kg K₂O /ha in shoot (1.06%) and 160 kg K₂O /ha in root (0.90%). It was also found at par with 80 kg K₂O /ha in shoot and 120 kg K₂O /ha in root. The result are in line with those obtained by Pervez *et al.* (2005) and Parmar (2006), who found that potassium application increased the content of K in cotton.

Root parameter

The data pertaining to individual effect of variety and potassium on root parameter of Bt cotton at different growth stages are given in Table 4.

Effect of varieties:

Root parameters like root radius, root volume and root length influenced significantly by different varieties of Bt cotton at various growth stages (Table 4). Among the different varieties, variety V₄ (Rashi-2) showed high value of root length of 5314, 45153 and 40706 cm at 30, 90 and

120 DAS, whereas it was higher in variety V₃ (Shakti-7) at 60 DAS. The value of root radius was higher in variety V₂ (0.146 mm) and V₄ (0.214 mm and 0.341 mm) at 30, 60 and 120 DAS. The variety V₂ (2.37cc), V₅ (50.21cc) and V₄ (147.00cc) showed the highest value of root volume at 30, 60 and 120 DAS. The value of root radius and root volume remains at par with varieties V₁ and V₃ at 30 DAS, respectively. Brouder and Cassman (1990) reported that the root length density, mean root diameter and root surface area density were significantly influenced by cultivars, depth of soil, time and combined effect of cultivar and time, whereas cultivars x depth, depth x time and cultivar x depth x time did not produce significant effect. Similar results were also observed by Zinzala (2000) on variety of groundnut and Sardhara (2003) on variety of wheat crop.

Effect of potassium:

The application of potassium produced significant effect on root radius, root volume and root length (Table 4). The root radius was obtained higher under application of potassium @ 120 kg/ha with the values of 0.137 mm, 0.196 mm and 0.323 mm at 30, 60 and 120 DAS, which were remained at par with 80 and 160 kg K₂O /ha and higher value of root radius obtained @ 160 kg K₂O /ha with value of 0.137mm and 0.288mm at 30 and 90 DAS, which were remained at par with 80 and 120 kg K₂O /ha. The highest root volume obtained @ 160 kg K₂O /ha with value of 50.42 cc and 142.30 cc at 60 and 120 DAS, which remained at par with 120 kg K₂O /ha application. The higher root volume obtained @ 120 kg K₂O /ha (103.90 cc) at 90 DAS, which remained at par over 160 kg K₂O /ha. The highest root length observed under (5010 cm) and 160 kg K₂O /ha (37042 cm) application at 30 and 60 DAS, which remained at par with 120 kg K₂O /ha at 60DAS. Zinzala (2000) was also reported that root volume and root length of groundnut as influenced by potassium rates.

Root influx of NPK at various growth stages

The data pertaining to individual effect of variety and potassium on root influx of nitrogen, phosphorus and potassium in *Bt* cotton at 30-60, 60-90 and 90-120 days growth stages are furnished in Table-5.

Effect of variety:

The root influx of N found higher (18.75×10^{-7} mg/cm/sec) with variety V_4 (Rashi-2) at 30-60 DAS, while root influx of N was found higher (18.62×10^{-7} mg/cm/sec) with variety V_5 (Mico-162) at 90-120 DAS, which remained at par with variety V_4 (Rashi-2). The root influx observed higher with value of P (3.47×10^{-7} mg/cm/sec and 4.02×10^{-7} mg/cm/sec) and K (25.15×10^{-7} mg/cm/sec and 13.57×10^{-7} mg/cm/sec) at 30-60 and 90-120 DAS. None of the variety produced any significant effect on root influx of N, P and K at 60-90 DAS. Polara *et al.* (1985) observed higher inflow rate of NPK was fairly high for the varieties TG-17 and OSN-2 than for J-11 and G-201. The inflow rate of K significantly influenced by variety of groundnut at all growth stages but no consistency trend was observed in case of NP inflow rate at different stages.

Effect of potassium:

The application of potassium at varying rates produced significant effect on root influx of nitrogen, phosphorus and potassium (Table 5). The root influx of N (16.23×10^{-7} mg/cm/sec) and P (3.47×10^{-7} mg/cm/sec) observed higher at 30-60 DAS with K level @ 120 kg/ha, which remained at par with 160 and 80 kg K_2O /ha, whereas root influx of K (23.73×10^{-7} mg/cm/sec) at 30-60 DAS and 90-120 DAS with potassium level 120 and 160 kg/ha, respectively. These observations are in agreement with those of Polara *et al.* (1985) and Zinzala (2000) for groundnut crop.

CONCLUSION

From the results, it can be concluded that variety V_4 (Rashi-2) showed significantly the highest dry matter yield,

root parameter and root influx of N. The application of potassium at 160 kg/ha gave the highest dry matter yield, whereas the highest root parameter and root influx of nitrogen and phosphorus found with the application of 120 kg K_2O /ha.

REFERENCES

- Brewster, J. L. and Tinker, P. B. (1970). Nutrient action flows in soil around roots. *Sci. Soc. Amre. Proc.*, **34**: 421-426.
- Brouder S. M. and Cassman K. G. (1990). Root development of two cotton cultivars in relation to potassium uptake and plant growth in a vermiculite soil. *Field Crop Res.*, **23**: 187-203.
- Cassman K. G.; Kerby T. A.; Roberts B.A.; Bryant, D. C and Brouder S. M. (1989). Differential response of two cotton cultivars to fertilizer and potassium. *Agron. J.*, **81**: 870-876
- Jackson, M. L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi. pp. 327-350.
- Johnson, C. M. and Ulrich, A. (1969). *Analytical Method for Use in PLANT Analysis*. California Agr. Exp. St. Bull., pp.766.
- Kanwar, J. S. and Chopra, S. L. (1976). *Analytical Agricultural Chemistry*. Kalyani Publishers, Ludhiana.
- Mulins, G. L. and Burmester, C. H. (1990). Dry matter, nitrogen, phosphorus and potassium accumulation by four cotton varieties. *Agron. J.*, **82**: 729-736.
- Nye, P. H. and Tinker, P. B. (1969). The concept of a root demand coefficient. *J. Appl. Ecol.*, **6**: 293-300.
- Pandey, P. M. (1969). Effect of potassium deficiency on the carbohydrate content in the cotton plant of various stages of its development. *Soviet Plant Physiol*, **16**: 9-16.
- Parmar, K. B. (2006). Nitrogen and potassium treatment for targeted

-
- yield of cotton. Ph.D. Thesis. (Unpublished) Submitted to Junagadh Agricultural University, Junagadh.
- Pervez, H.; Ashraf, M. and Makhdum, M. I. (2005). Influence of potassium rates and sources on seed cotton yield and yield component of some elite cotton cultivars. *J. Plant Nutrition*, **27(7)**: 1295-1317.
- Polara, K. B.; Patel, C. L. and Pathak, S. R. (1985). Effect of soil moisture stress in inflow rate on N, P, K, Fe and Mn at various growth stages of groundnut. *Annls. Arid Zone*, **23(1)**: 77-79.
- Sardhara, R. V. (2003). Inflow rate of nutrients in wheat cultivars as influenced by potassium levels at different period of growth. M.Sc. (Agri.) Thesis (Unpublished) Submitted to Gujarat Agricultural University, Sardarkrushinagar.
- Zinzala, V. J. (2000). Root influx of nutrients in the groundnut cultivars as influenced by different levels of potassium. M.Sc. (Agri.) Thesis (Unpublished) Submitted to Gujarat Agricultural University, Sardarkrushinagar.

Table 1: Effect of varieties and potassium on dry matter yield of *Bt* cotton

Treatments	30 DAS			60 DAS			90 DAS			120 DAS		
	Shoot (g/plant)	Root (g/plant)	Total Plant (g/ plant)	Shoot (g/plant)	Root (g/plant)	Total Plant (g/ plant)	Shoot (g/plant)	Root (g/plant)	Total Plant (g/ plant)	Shoot (g/plant)	Root (g/plant)	Total Plant (g/ plant)
Varieties												
V ₁ : Ankur-165	6.38	0.53	6.91	43.50	3.93	47.43	119.06	18.68	137.73	209.68	27.76	237.44
V ₂ : Vikram-5	6.61	0.65	7.25	45.18	4.10	49.28	127.34	19.79	147.13	242.12	31.28	273.40
V ₃ : Shakti-7	6.90	0.63	7.53	46.73	3.62	50.35	128.81	20.00	148.81	233.76	29.49	263.26
V ₄ : Rashi-2	7.16	0.68	7.83	61.46	6.72	68.18	136.86	21.18	158.04	282.56	38.92	321.48
V ₅ : Mico-162	6.91	0.66	7.57	58.16	6.44	64.60	134.52	20.60	155.12	262.50	33.47	295.80
S. Em.±	0.17	0.02	0.18	1.45	0.18	1.54	3.96	0.51	4.08	7.70	1.03	8.72
C.D. at 5%	0.51	0.06	0.52	4.31	0.58	4.55	11.72	1.51	12.09	22.80	3.03	25.80
K₂O levels(kg/ha)												
K ₁ : 0	6.01	0.57	6.58	43.40	4.50	47.89	117.51	18.53	136.04	227.22	30.05	257.27
K ₂ : 80	6.68	0.61	7.29	49.87	4.94	54.80	127.97	19.45	147.42	239.83	30.81	270.64
K ₃ : 120	7.05	0.67	7.72	54.93	5.28	60.21	135.18	20.72	155.80	255.65	33.33	288.98
K ₄ : 160	7.43	0.68	8.10	55.83	4.13	60.96	136.61	21.51	158.12	261.67	34.54	296.21
S. Em.±	0.15	0.02	0.16	1.30	0.16	1.38	3.54	0.46	3.65	6.89	0.92	7.80
C.D. at 5%	0.46	0.06	0.47	3.85	0.48	4.07	10.49	1.35	10.81	20.39	2.71	23.07

Table 2: Effect of varieties and potassium levels on nutrient content (%) in shoot at different growth stages of *Bt* cotton

Treatments	30 DAS			60 DAS			90 DAS			120 DAS		
	N	P	K	N	P	K	N	P	K	N	P	K
Varieties												
V ₁ : Ankur-165	2.47	0.23	1.62	2.29	0.23	1.63	1.90	0.19	1.72	1.50	0.15	1.07
V ₂ : Vikram-5	2.57	0.24	1.55	2.34	0.24	1.66	1.94	0.19	1.72	1.58	0.14	1.04
V ₃ : Shakti-7	2.51	0.23	1.60	2.32	0.23	1.63	1.95	0.19	1.75	1.54	0.15	1.00
V ₄ : Rashi-2	2.48	0.23	1.59	2.30	0.23	1.63	1.92	0.19	1.74	1.49	0.14	0.99
V ₅ : Mico-162	2.57	0.23	1.51	2.34	0.24	1.60	1.92	0.19	1.70	1.59	0.15	1.03
S. Em.±	0.041	0.004	0.026	0.033	0.004	0.027	0.025	0.003	0.022	0.028	0.003	0.023
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
K₂O levels(kg/ha)												
K ₁ : 0	2.58	0.22	1.51	2.37	0.23	1.55	1.93	0.19	1.65	1.54	0.15	0.96
K ₂ : 80	2.50	0.23	1.58	2.32	0.23	1.61	1.91	0.19	1.73	1.52	0.15	1.02
K ₃ : 120	2.52	0.24	1.61	2.33	0.24	1.68	1.93	0.19	1.75	1.53	0.15	1.06
K ₄ : 160	2.48	0.23	1.60	2.25	0.24	1.67	1.93	0.19	1.76	1.56	0.15	1.06
S. Em.±	0.037	0.003	0.023	0.30	0.003	0.024	0.022	0.020	0.020	0.025	0.002	0.021
C.D. at 5%	NS	NS	0.07	NS	NS	0.07	NS	NS	0.06	NS	NS	0.06

Table 3: Effect of varieties and potassium levels on nutrient content (%) in root at different stages of growth in *Bt* cotton

Treatments	30 DAS			60 DAS			90 DAS			120 DAS		
	N	P	K	N	P	K	N	P	K	N	P	K
Varieties												
V ₁ : Ankur-165	0.89	0.19	0.74	0.84	0.22	1.01	0.99	0.19	1.06	0.89	0.19	0.89
V ₂ : Vikram-5	0.87	0.19	0.74	0.83	0.22	1.05	0.98	0.19	1.03	0.87	0.18	0.86
V ₃ : Shakti-7	0.86	0.19	0.74	0.84	0.22	1.01	0.99	0.18	1.05	0.86	0.18	0.85
V ₄ : Rashi-2	0.90	0.18	0.73	0.84	0.21	1.00	0.97	0.18	1.03	0.89	0.18	0.85
V ₅ : Mico-162	0.91	0.19	0.74	0.84	0.21	1.03	0.96	0.19	1.06	0.91	0.18	0.86
S. Em.±	0.015	0.004	0.014	0.014	0.003	0.016	0.015	0.003	0.017	0.015	0.003	0.014
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
K₂O levels(kg/ha)												
K ₁ : 0	0.87	0.19	0.66	0.84	0.21	0.92	0.96	0.19	0.96	0.87	0.18	0.81
K ₂ : 80	0.88	0.19	0.74	0.83	0.22	1.03	0.96	0.19	1.05	0.88	0.18	0.85
K ₃ : 120	0.89	0.19	0.77	0.84	0.22	1.07	0.97	0.19	1.10	0.89	0.18	0.88
K ₄ : 160	0.90	0.19	0.77	0.84	0.21	1.05	0.98	0.18	1.07	0.90	0.18	0.90
S. Em.±	0.017	0.004	0.013	0.012	0.003	0.014	0.013	0.023	0.015	0.015	0.002	0.013
C.D. at 5%	NS	NS	0.04	NS	NS	NS	NS	NS	0.04	NS	NS	0.04

Table 4: Effect of varieties and potassium on root parameters of *Bt* cotton at different periods of crop growth

Treatments	Root Radius (mm)				Root Volume (cc)				Root length (cm)			
	Day after sowing				Day after sowing				Day after sowing			
	30	60	90	120	30	60	90	120	30	60	90	120
Varieties												
V ₁ : Ankur-165	0.136	0.173	0.264	0.292	2.32	43.40	92.90	127.70	4059	32407	42593	47357
V ₂ : Vikram-5	0.146	0.181	0.279	0.303	2.37	46.75	91.20	127.70	3676	32201	37564	45665
V ₃ : Shakti-7	0.136	0.165	0.275	0.315	2.31	43.50	94.30	137.60	4059	34982	40007	46470
V ₄ : Rashi-2	0.114	0.214	0.269	0.341	2.12	48.40	102.20	147.00	5314	25129	45153	40706
V ₅ : Mico-162	0.119	0.204	0.283	0.312	1.72	50.21	97.00	140.70	3905	28120	38780	45953
S. Em.±	0.004	0.003	0.005	0.006	0.044	0.92	2.64	2.53	189.9	596.4	1725	1956.4
C.D. at 5%	0.012	0.009	NS	0.021	0.13	2.71	NS	7.52	362.2	1765	5107	NS
K₂O levels(kg/ha)												
K ₁ : 0	0.113	0.180	0.263	0.301	1.97	41.51	84.70	125.40	5010	27700	39783	44483
K ₂ : 80	0.134	0.184	0.264	0.320	2.13	45.22	90.60	135.30	3833	29146	41639	42745
K ₃ : 120	0.137	0.196	0.281	0.323	2.26	48.67	103.90	141.50	3939	28383	42250	45792
K ₄ : 160	0.137	0.190	0.288	0.318	2.31	50.42	102.90	142.30	4036	37042	39605	47900
S. Em.±	0.003	0.003	0.004	0.006	0.039	0.82	2.360	2.26	169.9	533.4	1543.4	1749.9
C.D. at 5%	0.010	0.018	0.014	0.019	0.11	2.43	7.00	6.75	502.9	1578	NS	NS

Table 5: Effect of potassium levels and varieties on root influx of N, P, and K (mg/cm/sec) at different periods of growth stages

Treatments	N			P			K		
	$N_1 \times 10^{-7}$			$P_1 \times 10^{-7}$			$K_1 \times 10^{-7}$		
DAS	30-60	60-90	90-120	30-60	60-90	90-120	30-60	60-90	90-120
Varieties									
V ₁ : Ankur-165	11.98	7.36	11.65	2.32	1.18	2.74	15.99	13.46	8.24
V ₂ : Vikram-5	12.98	8.50	15.44	2.54	1.40	3.26	17.66	15.51	11.36
V ₃ : Shakti-7	12.80	8.30	13.60	2.32	1.27	3.00	16.17	14.92	8.57
V ₄ : Rashi-2	18.75	7.85	16.51	3.74	1.21	4.02	25.15	15.03	13.57
V ₅ : Mico-162	17.69	7.69	18.62	3.77	1.15	3.66	24.35	15.19	12.61
S. Em.±	0.95	0.53	0.63	0.18	0.10	0.12	1.07	0.84	0.62
C.D. at 5%	2.80	NS	1.88	0.52	NS	0.35	3.17	NS	1.84
K₂O levels(kg/ha)									
K ₁ : 0	12.47	7.76	14.90	2.42	1.29	3.17	15.92	14.13	9.15
K ₂ : 80	15.01	7.79	14.49	3.00	1.26	3.41	20.30	15.00	10.85
K ₃ : 120	16.23	7.90	14.51	3.47	1.27	3.35	23.73	15.70	11.20
K ₄ : 160	15.59	8.30	15.23	2.86	1.15	3.41	19.69	14.46	11.23
S. Em.±	0.85	0.47	0.57	0.16	0.09	0.11	0.97	0.76	0.56
C.D. at 5%	2.50	NS	NS	0.47	NS	NS	2.82	NS	1.65

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