Original Research Article

Yield and nutrient uptake by Byadgichilli (*Capsicum annuum* L.) as influenced by foliar spray of cow urine in a *Vertisol*

Abstract

A field experiment was conducted during *kharif* 2018 in the farmer's field at Agadi village (Tq: Hubballi) in Dharwad district to investigate the "Yield and nutrient uptake by Byadgichilli (*Capsicum annuum* L.) as influenced by foliar spray of cow urine in a *Vertisol*". Experiment consisted of 12 treatments with three replications. Results revealed that, two foliar applications of 15 per cent cow urine ~~one~~ each at 60 and 90 DAT recorded highest fruit yield (14.07 q ha^{-1}) which was on par with two foliar applications ~~at~~ten per cent (13.06 q ha^{-1}). **Control recorded lowest fruit yield of 9.68 q ha^{-1}**. Total uptake of nutrients (N: 90.84, P: 15.65, K: 158.94, S: 26.89, Ca: 53.14, Mg: 14.04 kg ha^{-1}) by Byadgichilli was highest in the treatment which receivedtwo foliar applications of 15 per cent cow urine one each at 60 and 90 DAT. ~~Foliar spray of 15 per cent cow urine is superior in improving the yield and nutrient uptake by Byadgichillies.~~

Key words: Cow urine, fruit yield, nutrients uptake

Introduction

ByadgiChilli is a long duration (180 to 210 days) and indeterminate crop requires timely manuring particularly at grand growth (60-75 DAT) and fruit development (90-105 DAT) stages.Chilliplants should have adequate supply of nitrogen during fruit development to enhance its yield. But, the conventional nitrogen fertilizers applied to soil as basal dose during transplanting and top dressed after 45 DAT are subjected to leaching, volatilization and run off losses leaving very little nitrogen available during fruit development. This results in lesser yield in chillies.In order to meet the timely and immediate requirement of nitrogen, foliar application of nitrogen throughurine in addition to top dressing of urea is very essential.On an average about 13.0 litres of urine will be excreted by a cow in a day. This urine gets lost due to percolation, evaporation and runoff in cattle shed if the floor of cattle shed is of ordinary type ~~particularly during rainy season~~, the volume of urine excreted by cow will be more.Hence urine excreted by farm animals can be used as source of nutrient ~~for foliar spray~~ after proper dilution with water~~. Analysis of cow urine revealed that, it is neutral in reaction (pH 7.10) and soluble~~

Comment [ns1]: Effect of foliar application of cow urine on yield and nutrient uptake by Byadgichilli (*Capsicum annuum* L.)

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salt content is 6.55 dS/ m. It contains 0.31 per cent N, 20 mg L^{-1} P, 0.93 per cent K, 72 mg L^{-1} of Ca + Mg. Thamhaneet *al*. (1965) reported that, cow urine contains 1 per cent N, 1.9 per cent K_2O and traces of P_2O_5 which can be used as source of liquid fertilizer. Besides it contains oxalic acid, hipuric acid, crietinine, eltine, enzymes, steroids, propiline oxide, ethylene oxide, glycosides, glucose, citric acid, alkalide, acetate, endesonine, carbolic acid and growth promoting substances (Agrawal, 2002).Foliar spray of cow urine at flowering and fruit development stages in chillimay significantly enhance fruit yield.Very little information is available about the foliar spray of cow urine as a source of nutrients in influencing the yield.Hence the present study was planned.

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Material and methods

A field experiment was conducted during *kharif*2018in thefarmer's field (Survey No. 88) at Agadi village (Tq.,Hubballi) in Dharwad district.The soil of the experimental site is *TypicChromustert*.

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Soil of the experimental site is clay in texture, neutral in pH (7.40), normal in soluble salts (0.26 dS/m), medium in organic carbon (6.90 g kg^{-1}), low in avail. nitrogen (188.65 kg ha^{-1}) and phosphorus (19.85 kg ha^{-1}), medium in potassium (290.50 kg ha^{-1}) and high in avail.sulphur (22.00 kg ha^{-1}). Cow urine was collected from a selected animal and analysed for its nutrient content and reaction (pH) and TSS content. The concentration of diluted cow urine solution fixed for foliar spray is based on TSS content of solution as indicated by EC values. It was observed that, 4, 6, 8, 10, 12, 14, 15 and 20 per cent solutions of cow urine after dissolving in bore well water recorded TSS contents of 0.84, 0.95, 1.06, 1.14, 1.27, 1.46, 1.56 and 2.43 dS m^{-1} respectively. Based on the critical limit of total salt content in spray solution as given by CSSRI, Karnal as 2 dS m^{-1}, fifteen per cent solution of cow urine was taken as upper limit. Based on the peak requirement of nutrients to chilli crop, time and frequency of foliar sprays were fixed as 60 and 90 days after transplanting (DAT). The treatments details are furnished in Table-1. All the treatments received uniform dose of recommended fertilizers (100:50:50 N, P_2O_5, K_2O Kg ha^{-1}) along with FYM of 25 tonnes ha^{-1}. 45 days old chilli seedlings were transplanted at 75 cm X 75 cm spacing on 29/ 07/ 2018. Completely matured red fruits were harvested in two stages, first on 10/ 01/ 2019 and second on 30/ 01/ 2019. These red fruits were sundried and yield was recorded by pooling the fruits of two pickings and expressed in quintals per hectare. Plants and red chilli fruits were

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analysed for major and secondary nutrients as per standard procedures after wet ashing of samples with di-acid (HNO_3: $HClO_4$) mixture.

Table 1. Treatment details

T_1	Control (Water spray at 60 & 90 DAT)
T_2	5 % cow urine spray at 60 DAT
T_3	10 % cow urine spray at 60 DAT
T_4	15 % cow urine spray at 60 DAT
T_5	5 % cow urine spray at 90 DAT
T_6	10 % cow urine spray at 90 DAT
T_7	15 % cow urine spray at 90 DAT
T_8	5 % cow urine spray at 60 & 90 DAT
T_9	10 % cow urine spray at 60 & 90 DAT
T_{10}	15 % cow urine spray at 60 & 90 DAT
T_{11}	1 % urea spray at 60 DAT
T_{12}	50 ppm NAA spray at 60 DAT

Note: RPP (Recommended Package of Practices) for chilli is 100:50:50 N, P_2O_5, K_2O Kg ha^{-1} + FYM 25 tonnes ha^{-1} is common for all the treatments.

Results and discussion

Fruit yield

Foliar application of 15 % cow urine at 60and 90 DAT (T_{10}) recorded highest fruit yield (14.07 q ha^{-1}) closely followed ~~by treatment (T_9) that received~~10% cow urine spray at 60and 90 DAT (13.06 q ha^{-1}) and ~~treatment (T_4) that received~~ 15 % cow urine spray at 60DAT (11.66 q ha^{-1}). The growth harmones present in cow urine stimulate meristematic tissue in chilli plants which lead to more flower buds and flowering. This might have formed

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more number of fruits in plants. Similar results on increased fruit yield were reported by Batra*et al.* (2006) and Chaurasia*et al.* (2005) in brinjal and tomato crops respectively. It was noticed that, treatments (T_4, T_7 and T_{10}) that received 15 per cent foliar spray recorded numerically higher fruit yield than treatments that received five (T_2, T_5 and T_8) and ten (T_3, T_6 and T_9) per cent foliar spray.This was due to increased absorption of nitrogen by chilli leaves leading to increased chlorophyll content and photosynthesis. Further the photosynthates were translocated to developing fruits facilitated by the presence of potassium (Prabhavathi*et al.*, 2009). Control (T_1) that received water spray recorded lowest fruit yield (9.68 q ha^{-1}) which was on par with treatment T_{12} that received 50 ppm NAA foliar spray at 60^{th} DAT (9.90 q ha^{1}) as well as treatment (T_{11}) that received urea spray (10.30 q ha^{-1}). This is obvious because of non-availability of N, P and K during flowering and fruit development stages in adequate amount otherwise supplied through urine spray. This has resulted in lower yield attributes.

Nitrogen

Significant difference existed between treatments with regard to nitrogen uptake by both plants and fruit samples. Highest nitrogen uptake (43.82 and 47.02 kg ha^{-1} for plant and fruits, respectively) was observed in treatment (T_{10}) that received two sprays of 15 per cent cow urine at 60 + 90 DAT closely followed by treatment (T_9) that received two foliar sprays of 10 per cent cow urine(35.89 and 37.48 kg ha^{-1} for plant and fruits, respectively). This was mainly due to high fruit yield recorded in this treatment compared to other treatments.This is obvious because of higher amounts of nitrogen supplied through foliar spray of urine. This higher amount of nitrogen stimulated the growth of chilli plants leading to increased fruit yield and subsequent increased uptake. Control (T_1) recorded lowest nitrogen uptake (12.03 and 14.94 kg ha^{-1} for plant and fruit samples respectively) and differed significantly from all other treatments.Treatment (T_{10}) that received two sprays of 15 per cent cow urine at 60 + 90 DAT recorded highest total uptake (90.84 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments with two sprays of cow urinerecorded higher uptake than treatments with one spray. Foliar sprays given on 60 and 90 DAT have closely synchronized with peak flowering and fruit development stages and during these stages due to high physiological activities there might be greater demand for nitrogen by the plant. The nitrogen uptake values are in accordance with the values reported earlier by Jadhav (2017) and Neelgar*et al.* (2013) for Byadgichilli. Control (T_1) recorded lowest total nitrogen uptake (26.97 kg ha^{-1}) and differed significantly from all other treatments. Lastly all treatments (T_2 to T_{10}) that received

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Comment [ns55]: Which resulted in significant reduction in lowest yield foliar spray of cow urine recorded higher total N uptake than treatments that received either water spray (T_1) or urea spray (T_{11}) or NAA spray (T_{12}).This was because of lower fruit yield along with leaching losses of nitrogen applied to the soil at the time of transplanting (45 DAT) through urea as top dressing. Further this treatment did not received N through foliar spray of urine.

Phosphorus

Highest uptake (7.78 and 7.87 kg ha^{-1} for plant and fruits, respectively) was observed in treatment (T_{10}) that received two sprays of 15 per cent cow urine at 60 + 90 DAT and differed significantly over all other treatments.This is obvious because of the presence of phosphorus (0.002 %) in cow urine. The absorbed phosphorus along with nitrogen enhances cell division, cell development leading to increased fruit yield. Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest total uptake (15.65 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments with two sprays of cow urine($T_{8,}$ T_9 & T_{10}) recorded higher uptake of phosphorus than treatments with one spray. Treatments receiving 15 per cent cow urine recorded numerically higher P uptake than treatments receiving 5 and 10 per cent cow urine spray. Control (T_1) recorded lowest phosphorus uptake (5.33 kg ha^{-1}) and differed significantly from all other treatments except T_{12}. All the treatments that received cow urine spray recorded higher phosphorus uptake (7.65 to 15.65 kg ha^{-1}) than treatments which were devoid of cow urine spray except treatment T_2 that recorded 7.01 kg ha^{-1} of phosphorus uptake. This was attributed to higher supply of phosphorus through foliar spray resulting in high fruit yield. Control recorded lowest uptake of phosphorus because, applied phosphorus at the time of transplanting might have been subjected to fixation, since the soil is slightly calcareous. The present values of phosphorus uptake closely with values reported earlier by Prabhavathi*et al.* (2009) for Byadgichilli.

Potassium

Treatment (T_{10}) that received two sprays of 15 per cent cow urine on 60 + 90 DAT recorded highest total uptake (158.94 kg ha^{-1}) and differed significantly from all other treatments except T_9 (157.43 kg ha^{-1}).This is obvious because of high K content in cow urine (0.93 %). Further, treatment with two sprays recorded higher uptake of potassium than treatments with one spray either at 60 or 90 DAT.Foliar sprays given at 60 and 90 DAT have closely synchronized with colour development in chilli fruits leading to increased potassium uptake. Treatments receiving 15 per cent cow urine recorded numerically higher potassium uptake than treatments receiving 5 and 10 per cent cow urine spray. Treatment with 50 ppm NAA spray recorded 79.91 kg ha^{-1} of total potassium uptake which differed significantly from treatment with one per cent urea spray (106.5 kg ha^{-1}) and control (T_1) recorded lowest potassium uptake (51.50 kg ha^{-1}). Potassium supplied through foliar spray of urine on 60 and 90 DAT directly enters the chilli fruits and participates in balancing acid: sugar ratio in fruits. Further it facilitates rapid transformation of chloroplasts (green colour) to chromoplasts. Because of these reasons, there was greater uptake of potassium at 105 and 140 DAT. Since the foliar spray of cow urine closely coincides with red colour development, there was increased uptake. Results of increased potassium uptake by chillies closely confirm the earlier findings reported by Prabhavathi*et al.* (2009), Ananthi*et al.* (2004).

Sulphur

Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest uptake (26.89 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments (T_8 to T_{10}) with two sprays of cow urinerecorded significantly higher uptake (17.49 and 26.89 kg ha^{-1}) than treatments with one spray. Treatments receiving 15 per cent cow urine spray recorded numerically higher S uptake than treatments receiving 5 and 10 per cent cow urine spray. Foliar spray of cow urine has increased sulphur uptake because of synergistic relationship between nitrogen and sulphur as they are constituents of proteins. Absorbed N by plant canopy stimulated sulphur uptake by plant roots. Control (T_1) recorded lowest sulphur uptake (4.78 kg ha^{-1}) and differed significantly from all other treatments. Prabhavathi*et al.* (2009) reported that, foliar spray of potassium sulphate to chilli crop increased sulphur uptake because of sulphatesulphur present in sulphate of potash because of its direct absorption by leaves and fruits.

Calcium

Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest uptake (53.14 kg ha^{-1}) and differed significantly from rest of the treatments. Treatments receiving 15 per cent cow urine spray recorded numerically higher Ca uptake than treatments receiving 5 and 10 per cent spray. This was mainly due to high fruit yield recorded in this treatment compared to other treatments and also due to higher production of fruit yield with high concentration of Ca and N given through foliar spray of cow urine because of rapid cell elongation, cell division and more number of leaves which resulted in more vegetative and reproductive growth. Increased uptake of calcium was due to calcium supplied through urine spray (50 mg L^{-1}) and its absorption by leaves, stems and to limited extent by fruits. Results of calcium uptake obtained in the present investigation are in accordance with the values reported earlier by Jadhav (2017).

Magnesium

Highest magnesium uptake (5.40 and 8.64 kg ha^{-1} for plant and fruits, respectively) was observed in treatment (T_{10}) that received 15 per cent cow urine spray on 60 + 90 DAT and differed significantly from all other treatments. Control (T_1) recorded lowest magnesium uptake (2.22 and 2.74 kg ha^{-1} for plant and fruit samples respectively). Further treatment (T_{12}) with 50 ppm NAA spray recorded 2.77 and 3.79 kg ha^{-1} of magnesium uptake for plants and fruits that was on par with treatment (T_{11}) that received urea spray (2.67 and 4.10 kg ha^{-1} for plants and fruits, respectively). Treatment (T_{10}) that received two sprays of 15 per cent cow urine recorded highest total uptake (14.04 kg ha^{-1}) and differed significantly from rest of the treatments. This might be due to high dry matter production and Magnesium content of 22.22 mg L^{-1} present in cow urine which might be contributed to greater chlorophyll formation which in turn led to more vegetative growth that increased the dry matter production.

Comment [ns56]: Write down the results of nutrient uptake all together as the trend with respect to nitrogen,phosphorous,potassium, calcium and magnesium is almost similar

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Table 2: Effect of foliar spray of cow urine on yield parameters and dry fruit yield of chilli (Cv. Dyavnur)

Treatments	No. of fruits/plant/ picking	100 fruit weight (g)	Fruit yield (q ha^{-1})
T_1 - Control (Water spray at 60 & 90 DAT)	16.85	148.80	9.68
T_2 - 5 % cow urine spray at 60 DAT	17.50	151.97	10.01
T_3 - 10 % cow urine spray at 60 DAT	18.82	154.27	10.55
T_4 - 15 % cow urine spray at 60 DAT	21.95	163.10	11.66
T_5 - 5 % cow urine spray at 90 DAT	19.20	155.17	10.80
T_6 - 10 % cow urine spray at 90 DAT	20.75	161.70	11.30
T_7 - 15 % cow urine spray at 90 DAT	21.15	163.17	11.65
T_8 - 5 % cow urine spray at 60 & 90 DAT	20.30	160.53	11.25
T_9 - 10 % cow urine spray at 60 & 90 DAT	23.13	167.67	13.06
T_{10} - 15 % cow urine spray at 60 & 90 DAT	25.78	168.73	14.07
T_{11} - 1 % urea spray at 60 DAT	15.85	151.80	10.30
T_{12} - 50 ppm NAA spray at 60 DAT	14.78	148.5	9.90
S.Em. ±	1.27	5.45	0.74
C.D. (0.05)	3.72	16.56	2.17
C.V. (%)	11.15	10.52	11.44

Table 3: Effect of foliar spray of cow urine on the uptake of N, P and K nutrients (kg ha^{-1}) by chilli (Cv. Dyavnur) at harvest

Treatments	Nitrogen			Phosphorus			Potassium		
	Plant	**Fruit**	**Total**	**Plant**	**Fruit**	**Total**	**Plant**	**Fruit**	**Total**
T_1 - Control (Water spray at 60 & 90 DAT)	12.03 (1.16)	14.94 (1.54)	26.97	1.42 (0.14)	3.91 (0.40)	5.33	25.00 (2.41)	26.5 (2.55)	51.50
T_2 - 5 % cow urine spray at 60 DAT	21.63 (1.34)	25.62 (2.56)	47.25	2.87 (0.18)	4.14 (0.41)	7.01	43.11 (2.67)	46.25 (2.86)	89.36
T_3 - 10 % cow urine spray at 60 DAT	24.68 (1.39)	28.06 (2.66)	52.74	3.26 (0.18)	4.39 (0.41)	7.65	52.04 (2.93)	56.67 (3.19)	108.71
T_4 - 15 % cow urine spray at 60 DAT	30.82 (1.53)	32.99 (2.83)	63.81	5.49 (0.28)	5.59 (0.48)	11.08	64.46 (3.20)	68.95 (3.42)	125.29
T_5 - 5 % cow urine spray at 90 DAT	25.08 (1.40)	28.94 (2.68)	54.02	4.01 (0.23)	4.55 (0.42)	8.56	53.76 (3.00)	59.87 (3.34)	113.63
T_6 - 10 % cow urine spray at 90 DAT	28.02 (1.52)	31.73 (2.80)	59.75	4.66 (0.25)	4.79 (0.42)	9.45	57.70 (3.13)	62.56 (3.39)	120.26
T_7 - 15 % cow urine spray at 90 DAT	29.65 (1.52)	33.15 (2.84)	62.80	4.97 (0.25)	5.14 (0.44)	10.11	61.06 (3.13)	64.23 (3.29)	133.41
T_8 - 5 % cow urine spray at 60 & 90 DAT	28.04 (1.51)	30.48 (2.71)	58.52	4.19 (0.22)	4.74 (0.42)	8.93	59.99 (3.23)	63.25 (3.40)	123.24
T_9 - 10 % cow urine spray at 60 & 90 DAT	35.89 (1.59)	37.48 (2.87)	73.37	6.34 (0.28)	6.69 (0.51)	13.03	76.76 (3.40)	80.67 (3.57)	157.43
T_{10} - 15 % cow urine spray at 60 & 90 DAT	43.82 (1.61)	47.02 (3.34)	90.84	7.78 (0.29)	7.87 (0.56)	15.65	78.25 (2.87)	80.69 (2.95)	158.94
T_{11} - 1 % urea spray at 60 DAT	24.64 (1.38)	26.98 (2.62)	51.62	3.19 (0.18)	4.29 (0.41)	7.48	51.25 (2.87)	55.25 (3.09)	106.50
T_{12} - 50 ppm NAA spray at 60 DAT	19.55 (1.29)	23.76 (2.40)	43.31	2.63 (0.174)	4.04 (0.40)	6.67	38.35 (2.53)	41.56 (2.74)	79.91
S.Em. ±	1.61	1.63	2.67	0.27	0.21	0.56	2.39	1.16	3.75
C.D. (0.05)	4.88	4.88	7.82	0.82	0.71	1.65	7.23	3.52	11.01
C.V. (%)	5.66	6.45	6.04	4.64	5.95	5.52	8.12	7.01	5.70

Figures in parenthesis indicate nutrient concentration in per cent
DAT - Days after transplanting

Table 4: Effect of foliar spray of cow urine on the uptake of secondary nutrients (kg ha^{-1}) by chilli (Cv. Dyavnur)

Treatments	Sulphur			Calcium			Magnesium		
	Plant	**Fruit**	**Total**	**Plant**	**Fruit**	**Total**	**Plant**	**Fruit**	**Total**
T_1 - Control (Water spray at 60 & 90 DAT)	2.07 (0.20)	2.71 (0.20)	4.78	8.29 (0.8)	10.64 (1.1)	18.93	2.22 (0.20)	2.74 (0.23)	4.96
T_2 - 5 % cow urine spray at 60 DAT	3.55 (0.22)	6.30 (0.63)	9.85	17.76 (1.1)	13.01 (1.3)	30.77	2.80 (0.25)	4.03 (0.28)	6.83
T_3 - 10 % cow urine spray at 60 DAT	4.08 (0.23)	9.57 (0.92)	13.65	15.09 (0.85)	10.02 (0.95)	25.11	2.63 (0.22)	3.90 (0.25)	6.53
T_4 - 15 % cow urine spray at 60 DAT	7.04 (0.35)	10.81 (0.93)	17.85	15.0 (0.75)	10.37 (0.89)	25.37	2.70 (0.19)	3.62 (0.22)	6.32
T_5 - 5 % cow urine spray at 90 DAT	4.83 (0.27)	10.44 (0.97)	15.27	13.44 (0.75)	9.18 (0.85)	22.62	2.16 (0.19)	3.74 (0.22)	5.90
T_6 - 10 % cow urine spray at 90 DAT	5.52 (0.30)	10.58 (0.94)	16.10	21.20 1.15)	14.91 (1.32)	36.11	3.73 (0.31)	5.53 (0.32)	9.26
T_7 - 15 % cow urine spray at 90 DAT	6.43 (0.33)	11.68 (1.00)	18.11	15.60 (0.8)	11.06 (0.95)	26.66	2.91 (0.20)	3.90 (0.25)	6.80
T_8 - 5 % cow urine spray at 60 & 90 DAT	5.57 (0.30)	11.92 (1.06)	17.49	16.71 (0.9)	12.93 (1.15)	29.64	3.26 (0.20)	4.64 (0.29)	7.90
T_9 - 10 % cow urine spray at 60 & 90 DAT	8.80 (0.39)	14.35 (1.09)	23.15	20.31 (0.90)	20.88 (1.60)	41.19	3.56 (0.23)	6.54 (0.32)	10.1
T_{10} - 15 % cow urine spray at 60 & 90 DAT	10.88 (0.40)	16.01 (1.13)	26.89	29.94 (1.1)	23.20 (1.65)	53.14	5.40 (0.34)	8.64 (0.36)	14.04
T_{11} - 1 % urea spray at 60 DAT	3.93 (0.22)	9.17 (0.89)	13.10	16.07 (0.9)	10.81 (1.05)	26.88	2.67 (0.23)	4.10 (0.26)	6.77
T_{12} - 50 ppm NAA spray at 60 DAT	3.18 (0.21)	6.47 (0.65)	9.65	17.42 (1.15)	11.84 (1.20)	29.26	2.77 (0.25)	3.79 (0.28)	6.56
S.Em. ±	0.32	0.18	0.81	1.55	1.19	1.63	0.24	0.22	0.49
C.D. (0.05)	0.95	0.55	2.37	4.87	3.95	5.01	0.75	0.71	1.43
C.V. (%)	6.23	5.12	7.27	5.56	3.59	3.32	4.10	4.95	3.95

Figures in parenthesis indicate nutrient concentration in per cent

DAT - Days after transplanting