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Effect of Cow Urine Foliar Spray on Quality Attributes and Chemical Characteristics of Byadgi chilli (*Capsicum annuum* L.) in a Vertisol

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Authors' contributions

This work was carried out in collaboration among all authors. Author KLS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BIB and STH managed the analyses of the study. Author MP managed the literature searches. All authors read and approved the final manuscript.

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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 "Effect of cow urine foliar spray on quality attributes and chemical characteristics of Byadgi chilli (*Capsicum annuum* L.) in a Vertisol". Experiment consisted of 12 treatments with three replications laid out in Completely Randomized Block Design. Results revealed that, two foliar applications of 15 per cent cow urine one each at 60 and 90 DAT recorded highest colour value (201.65 ASTA units), closely followed by treatment that received two sprays of 10 per cent cow urine on 60 + 90 DAT (194.50 ASTA units). Highest oleoresin content (20.23%) was noticed in the treatment that received 15 per cent cow urine spray on 60 + 90 DAT which was on par with treatment that received two sprays of 10 per cent cow urine (19.56%). Highest capsaicin content (0.16%) was recorded in the treatment that received 15 % cow urine spray at 60 DAT as well as cow urine spray at 60 DAT + 90 DAT and also 50 ppm NAA spray at 60 DAT.

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Foliar spray of cow urine did not significantly influenced the total ash, total sugars and total ether extract contents in fruits which ranged from 5.95 to 6.96, 18.20 to 19.89 and 14.10 to 15.20 per cent respectively. Treatment that received one spray of 15 per cent cow urine on 90 DAT recorded numerically highest (6.96%) total ash closely followed by treatment (6.83%) that received five per cent foliar spray at 60 + 90 DAT. Treatment that received two sprays of 15 per cent cow urine recorded numerically highest (19.89%) total sugars closely followed by treatment (19.78%) that received 5 per cent foliar spray at 90 DAT. Treatment that received two sprays of 10 per cent cow urine recorded highest total ether extract (15.20%) closely followed by treatment (14.93%) that received 5 per cent foliar spray at 60 + 90 DAT.

Keywords: Cow urine; colour value; oleoresin; capsaicin; total ash; total sugar; total ether extract.

1. INTRODUCTION

Byadgi chilli 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. Chilli plants 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 through urine 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 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. Thamhane et al. [1] 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 [2]. Foliar spray of cow urine at flowering and fruit development stages in chilli may significantly enhance quality attributes and chemical characteristics. Very little information is available about the foliar spray of cow urine as a source of nutrients in influencing the quality attributes and chemical characteristics. Hence the present study is planned.

2. MATERIALS AND METHODS

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

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. Quality attributes and chemical characteristics were analysed as per standard procedures.

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
T10	15 % cow urine spray at 60 & 90 DAT
T11	1 % urea spray at 60 DAT
T12	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

2.1 Quality Parameters

A composite sample of sun dried red chilli fruits was collected from each treatment.

Whole fruits were depediceled, powdered and used for the analysis of quality parameters.

Total extractable red colour in sundried red chilli fruits was determined by extracting red colour with isopropanol and using potassium dichromate solution as std. colour. The extracted red colour intensity was measured in spectrophotometer at 450 nm as outlined by Mahindru [3]. Oleoresin content in red chilli fruits was determined by extracting with ethylene dichloride in soxhlet apparatus and determined the weight as outlined by AOAC [4]. Capsaicin content in chilli fruits was determined by HPLC method as outlined by Collins et al. [5]. Chemical properties like ash and ether extracts were determined by adopting std. procedures as outlined by Mahindru [3]. Lastly total sugars in red chilli fruits were determined by std. procedure of Thimmaiah [6].

3. RESULTS AND DISCUSSION

3.1 Quality Attributes

3.1.1 Colour value

There were significant variations in the colour value of red chilli fruits between treatments. The highest colour value (201.65 ASTA units) was noted in the treatment (T_{10}) receiving 15% cow urine spray followed by treatment (T_9) receiving two 10% cow urine sprays at 60+ 90 DAT (194.50 ASTA units) (Table 2). In this treatment, the highest colour value of fruit (T_{10}) was ascribed to enhanced soil potassium intake combined with direct leaf absorption of potassium. Since cow urine comprises potassium (0.93%), foliar spray at 60 and 90 DAT is closely synchronized with chilli fruit colour development. Cazi [7] indicated a direct relation between chilli fruit colour value and plant supply of potassium. Bidari [8] also noted that during colour development there was a sudden rise in plant potassium absorption. Treatments getting two cow urine foliar sprays were noted to have a greater colour value than one spray. This could be due to the fast conversion of chloroplast into chromoplast facilitated by the timely foliar spray supply of potassium.

An adequate ratio of N to K (N: K) in the fertilizer appears to be very important for colour development. It appears that the ratio of 1:3.0 is optimal for better colour development as it exists in treatments treated with cow urine. High potassium content in 15% foliar urine spray could have brought better balance between acids and sugars in chilli fruits owing to enhanced photosynthates translocation resulting in proper maturation and red colour growth. Because potassium is an activator of many enzymes and also acts as a catalyst, the synthesis of capsanthin and capsorubins [9] is better supported by the timely supply of potassium at the needed sites on the plant canopy by foliar spraying of cow urine. The results are closely in line with Bagal et al. [10], Nanadal et al. [11], Suresh [12] and Ananthi et al. [13] findings. Harinadh Babu Bokkisam et al. [14] recorded similar observation on the impact of N: K ratios on chilli quality. In the current research, the ASTA colour values obtained for Dyavnur cultivar are closely in line with the previously reported colour values of Prabhavathi et al. [15], Pankar

and Magar [16] and Savitha et al. [17], Bidari [8], Jadhav [18] and Somimol [19].

Control reported the lowest colour value (123.51 ASTA units) that could be due to insufficient potassium supply to chilli crop. There may also be some dilution impact due to water spray that results in reduced potassium concentration in the fruit [20]. Treatment (T_{11}) receiving 1% urea spray showed a relatively reduced colour value than treatments sprayed with urine (T_2 to T_{10}). Lack of potassium in sprayed urea treatment has produced low colour fruits, while urine sprayed treatments contain potassium (0.93%) in addition to phosphorus, calcium and magnesium that may have enhanced the colour value.

3.1.2 Per cent oleoresin

Oleoresin is a viscous, semi-solid gel-like substance containing both essential oil and non-volatile components from chillies. Oleoresin allows for a better and more consistent distribution of flavour to food products and is added in a diluted form to the food. In the current research, the highest oleoresin content (20.23%) was observed in the treatment (T_{10}) receiving 15% cow urine spray on 60 + 90 DAT, which was on par with treatment (T_9) receiving two 10 % cow urine sprays (19.56%) and treatment (T_8) receiving two 5% cow urine sprays (18.69%) (Table 2). High oleoresin content was due to foliar sprays of cow urine that led to increased carotenoid synthesis and partitioning of these carotenoids and other chemical properties. The urine of cow comprises 0.0025% sulphur. Chilli seeds contain volatile oil consisting of fatty acids such as palmitic acid, stearic acid, oleic acid and linoleic acid. Sulphur plays a part in the synthesis of oil in seeds [21]. Sulphur provided by foliar urine spray on 60 and 90 DAT has synchronized closely with fruit development, especially chilli seeds, which could have led to enhanced oil synthesis in plants. This has led in bold seed formation resulting in enhanced oleoresin. It is recognized that potassium and sulphur in chillies are respectively accountable for the synthesis of colour and oleoresin. High potassium content (0.93%) of cow urine led in increased potassium absorption leading to higher carbohydrate synthesis. In addition, the ratio of N: K (1:3) in cow urine appeared to be optimal for improved leaf absorption of potassium. Harinadh Babu Bokkisam et al. (2010) recorded similar findings on the impact of N: K ratios on chilli quality. Like N: K ratio, N: S ratio is also essential in many plants in protein and oil synthesis. N: S proportion (124: 1) as noted in cow urine may be suitable for better use of sulphur in the current research. Therefore, foliar spray of cow urine led in a higher synthesis of oleoresin in the essential volatile oil of chillies in chilli fruits.

Only water spray reported the lowest oleoresin (11.50%). This might be due to reduced nutrient absorption, especially the sulphur and the plants were succulent due to water spray. The fruit pericarp was very thin and light in colour in this treatment. Similarly, low oleoresin content (13.67%) was also reported by NAA sprayed treatment (T_{12}). This was also true in this treatment due to absence of sulphur. Prabhavathi et al. [22] indicated that, potassium sulphate foliar spray had enhanced oleoresin content in chilli fruit relative to muriate of potash. The values reported previously by Somimol [19] and Neelgar [23] strongly agree with the oleoresin content reported in this study.

3.1.3 Per cent capsaicin

Capsaicin, the pungent principle of chillies, is an alkaloid concentrated in chilli fruit placenta. Cow urine foliar spray significantly influenced the content of capsaicin in fruits, but there was no definite relationship between concentration and time of urine foliar spray.

Foliar spray of 15% cow urine at 60 DAT, 50 ppm NAA spray and 15% cow urine at 60 + 90 DAT led in the highest content of fruit capsaicin (0.16%) (Table 2). Capsaicin is an alkaloid and is an isodecyclenic acid vanillylamide [24]. Cow urine includes amide form of nitrogen. Pungency is accountable for the NH_2 molecule present in the capsaicin structure side chain. Foliar spray of 15% cow urine led in greater absorption of nitrogen and foliage absorbed nitrogen (NH_2-N) seemed to play a direct part in the formation of amide molecule present in the capsaicin structure side chain. The present findings are consistent with the findings of Anantakrishna and Govindarajan [25], who reported amide molecule synthesis in capsaicin structure as being closely related to nitrogen uptake. Further high uptake of nitrogen by plants in cow urine foliar spray treatment resulted in increased canopy and leaf size of plants. Bennet and Kirby [26] report that there is a direct relationship between the area of the leaf and the content of capsaicin in the fruit, since capsaicin is synthesized from photosynthates such as phenylalanine, valine and leucine produced in the leaves.

Critical examination of the data revealed that, regardless of concentrations, frequency and time of cow urine foliar spray, all treatments receiving cow urine foliar spray had a higher capsaicin content than control (0.04%). It was noted that there was no definite relationship between capsaicin content in fruit and concentration and time of cow urine foliar spray. This was due to the inherent narrow variation range (0.10 to 0.26%) in the chilli fruit capsaicin content. Practices in nutrient management may change the content of capsaicin in fruits within a given range. Rowland et al. [27] noted that the content of capsaicin in fruit is a conserved character and is synthesized on the cross walls of capsicum fruit in specialized gland cells and is genetically regulated. Therefore, foliar cow urine spray may not substantially increase the content of capsaicin in chillies. Pankar and Magar [16], Bidari [8] and Somimol [19] for Byadgi chillies strongly agree with the outcomes of capsaicin content in Byadgi chilli cultivar acquired in the current inquiry.

Control showed lowest content of capsaicin (0.04%) due to water spray and 50% of nitrogen provided as a basal dose during transplantation and the remaining 50% as top dressed at 45 DAT may not be adequate to enhance the content of capsaicin. This is apparent as a result of leaching nitrogen losses applied to soil. Somimol [19] revealed that water-soluble fertilizer foliar spray of 19: 19: 19 resulted in enhanced fruit capsaicin content. This was ascribed to the presence in 19: 19: 19 fertilizers with four and a half percent Amide-N content, easily absorbed by leaves and fruits.

3.2 Chemical Parameters of Chilli Fruits

Similar to physical properties, foliar application of cow urine did not significantly influenced the chemical properties of chilli fruits at harvest (Tables 3 & 4). Ash content of chilli fruits indicates the minerals or nutrients present in fruits. Whereas the ether extracts indicate the volatile and non-volatile oils present in fruits. In the present investigation, nutrients supplied through foliar spray have limited role in altering these chemical properties. In all chilli cultivars chemical properties vary in a narrow range might be because of inherent nature of fruits. However, in the present investigation, increased concentration of cow urine has resulted in increased ash content. This could be due to the nutrients provided by the spray of urine. The values of chemical properties obtained in the current inquiry for Byadgi chillies (Cv. Dyavnur) are closely in line with the values previously reported by Bidari [8] and Pankar and Magar [16] and Farrell [20].

Table 2. Effect of foliar spray of cow urine on quality parameters of chilli fruits (Cv. Dyavnur)

Treatments	Colour value (ASTA units)	Oleoresin (%)	Capsaicin (%)
	Red chilli fruits		
T_1 - Control (Water spray at 60 & 90 DAT)	123.51	11.50	0.04
T_2 - 5 % cow urine spray at 60 DAT	127.70	12.56	0.08
T_3 - 10 % cow urine spray at 60 DAT	136.92	15.67	0.12
T_4 - 15 % cow urine spray at 60 DAT	152.64	17.05	0.16
T_5 - 5 % cow urine spray at 90 DAT	154.14	16.45	0.13
T_6 - 10 % cow urine spray at 90 DAT	160.41	17.25	0.14
T_7 - 15 % cow urine spray at 90 DAT	169.68	18.13	0.14
T_8 - 5 % cow urine spray at 60 & 90 DAT	178.83	18.69	0.15
T_9 - 10 % cow urine spray at 60 & 90 DAT	194.50	19.56	0.14
T_{10} - 15 % cow urine spray at 60 & 90 DAT	201.65	20.23	0.16
T_{11} - 1 % urea spray at 60 DAT	125.19	17.78	0.13
T_{12} - 50 ppm NAA spray at 60 DAT	162.66	13.67	0.16
S.Em. ±	6.57	0.69	0.012
C.D. (0.05)	20.23	1.95	0.035
C.V. (%)	7.56	7.29	8.46

DAT - Days after transplanting

RDF - 100:50:50 N, P_2O_5 and K_2O kg ha^{-1} respectively + FYM (25 t ha^{-1}) is common for all the treatments

Table 3. Effect of foliar spray of cow urine on ash and total sugar contents in red chilli fruits (Cv. Dyavnur)

Treatments	Acid insoluble ash	Acid soluble ash	Total ash	Total sugars
		(%)		
T_1 - Control (Water spray at 60 & 90 DAT)	0.33	5.62	5.95	18.20
T_2 - 5 % cow urine spray at 60 DAT	0.37	5.85	6.22	18.95
T_3 - 10 % cow urine spray at 60 DAT	0.41	5.88	6.29	19.25
T_4 - 15 % cow urine spray at 60 DAT	0.52	6.04	6.56	19.29
T_5 - 5 % cow urine spray at 90 DAT	0.58	6.17	6.75	19.78
T_6 - 10 % cow urine spray at 90 DAT	0.48	5.97	6.45	19.22
T_7 - 15 % cow urine spray at 90 DAT	0.43	6.53	6.96	19.77
T_8 - 5 % cow urine spray at 60 & 90 DAT	0.54	6.29	6.83	19.63
T_9 - 10 % cow urine spray at 60 & 90 DAT	0.56	6.11	6.67	19.50
T_{10} - 15 % cow urine spray at 60 & 90 DAT	0.59	6.21	6.80	19.89
T_{11} - 1 % urea spray at 60 DAT	0.40	5.67	6.07	18.83
T_{12} - 50 ppm NAA spray at 60 DAT	0.47	5.72	6.19	18.52
S.Em. ±	0.05	0.13	0.07	0.05
C.D. (0.05)	NS	NS	NS	NS
C.V. (%)	4.19	5.42	4.23	6.67

DAT - Days after transplanting
RDF - 100:50:50 N, P_2O_5 and K_2O kg ha^{-1} respectively + FYM (25 t ha^{-1}) is common for all the treatments
NS – Non-significant

Table 4. Effect of foliar spray of cow urine on ether extracts of red chilli fruits (Cv. Dyavnur)

Treatments	Volatile ether extract (VEE)	Non-volatile ether extract (NVEE)	Total ether extract (TEE)
		(%)	
T_1 - Control (Water spray at 60 & 90 DAT)	0.17	13.93	14.10
T_2 - 5 % cow urine spray at 60 DAT	0.19	14.19	14.38
T_3 - 10 % cow urine spray at 60 DAT	0.20	14.23	14.43
T_4 - 15 % cow urine spray at 60 DAT	0.20	14.12	14.32
T_5 - 5 % cow urine spray at 90 DAT	0.22	14.54	14.76
T_6 - 10 % cow urine spray at 90 DAT	0.21	14.63	14.84
T_7 - 15 % cow urine spray at 90 DAT	0.25	14.42	14.67
T_8 - 5 % cow urine spray at 60 & 90 DAT	0.24	14.69	14.93
T_9 - 10 % cow urine spray at 60 & 90 DAT	0.25	14.95	15.20
T_{10} - 15 % cow urine spray at 60 & 90 DAT	0.26	14.56	14.82
T_{11} - 1 % urea spray at 60 DAT	0.18	14.03	14.21
T_{12} - 50 ppm NAA spray at 60 DAT	0.19	14.12	14.31
S.Em. ±	0.25	0.49	0.57
C.D. (0.05)	NS	NS	NS
C.V. (%)	5.43	6.25	4.14

DAT - Days after transplanting
RDF - 100:50:50 N, P_2O_5 and K_2O kg ha^{-1} respectively + FYM (25 t ha^{-1}) is common for all the treatments
NS – Non-significant

4. CONCLUSION

Two foliar sprays of 15% cow urine has recorded highest Quality attributes and Chemical characteristics. Irrespective of the concentration and frequency of foliar spray of cow urine, Quality attributes and Chemical characteristics of Byadgi chilli has increased because of cow urine foliar spray over control.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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