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Fodder yield and quality of baby corn (*Zea mays* L.) as affected by nitrogen and zinc fertilization

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Abstract
A field experiment was conducted during Rabi season of 2020 at Fodder Production Farm, Livestock Research Station, Lam Guntur of Sri Venkateswara Veterinary University to find out the yield and quality of green fodder of baby corn under different nutrient management practices. Application of 100 kg N/ha along with 30 kg ZnSo4/ha had significantly improved the yield & quality attributes of baby corn. Further with this levels of application the yield and quality parameters except crude fiber recorded maxim values *i.e*., plant height (178.46) cm and No of leaves/plant (12.00), leaf to stem ratio (1.01), baby corn yield (2597.47 kg/ha), green Fodder Yield (44.6 t/ha), Dry fodder yield (8.9 t/ha), Crude protein content (8.94%), Crude Protein Yield (848kg/ha) under irrigated conditions of Krishna Zone of Andhra Pradesh.

Keywords: Baby corn, green fodder, nitrogen, zinc, crude protein

1. Introduction

Milk production in the country has increased from 146.3 million tonnes in 2014-15 to 198.4 million tonnes in 2019-20. Annual Growth Rate of milk production was 6.27 percent during 2014-15, thereafter, there was a steady increase. In 2019-20, milk production increased by 5.68 per cent as compared to the previous year.

As per a study on the demand for milk conducted by the National Dairy Development Board (NDDB), the estimated demand for 2030 at an All India level is 266.5 million metric tonnes for milk and milk products [1].

But despite these estimates, the productivity potential of the Indian milch herd is a major cause of concern, which can be because of the both intrinsic (low genetic potential) and extrinsic (poor nutrition/feed management) [2]. Empirical studies have shown that enhancing the quality and quantity of green fodder has a greater impact on increasing milk productivity than breed.

The deficit of dry and green fodder in India in 2020 was around 12 per cent and 30 per cent, respectively [3]. With increasing livestock population and policy makers focusing on genetic up gradation of cattle by cross-breeding programmes, the demand for both green and dry fodder is expected to increase considerably to 1,012 million tonnes and 631 million tonnes, respectively, by 2050 [3].

The lack of timely availability of nutritionally rich feed and fodder is a major factor affecting the productivity of farm animals throughout India [4]. Recent studies revealed that the wholesale price index of cattle feed rose much faster than that of milk after 2012. Hence, a strategic approach is needed to improve the availability of the quality green fodders through proper agronomic interventions for a sustainable dairy sector as well as livestock health [5].

Baby corn (*Zea mays* L.) being one of the most important dual purpose crops is grown widely round the year for its cob as well as green fodder in India. It has an edge over the other cultivated annual fodder crops due to its higher production potential, wider adaptability, fast growing nature and excellent fodder quality free from toxicants.

Baby corn production has been directly integrated with dairying farms in different countries because only 13-20% of fresh ear weight is used as human food and the rest (silk, husk and green stalk) can be used as excellent feed materials for milch ruminants to improve their productivity [6].

It is becoming popular among the growers in peri-urban areas in recent years due to its diversity and high net returns [7]. Recently baby corn has gained popularity in Uttar Pradesh Haryana Maharashtra Telangana Andhra Pradesh Karnataka Rajasthan of India which is grown in 943 million hectares with the production of 24.3 5 million tonnes and it will continue to increase in the future, making available their various by-products and wastes for use as animal feed Use of such non-food parts from agricultural products as animal feed will not only enhance food security but also contribute to alleviation of environmental problems associated with their disposal.

By adopting the good agro-techniques, it is possible to produce 40-45 t/ha of fresh green fodder, which could raise a net income of Rs. 40-45×103 /ha as such it may prove to be a boon for small and marginal farmers for improving their socio-economic conditions.

Though it is fed to the animals, information on green fodder production and nutritional value of baby corn is limited.

Hence, a field experiment was planned to find out the yield and chemical composition of baby corn's green fodder under varying nutrient management practices.

2. Materials and Methods

A field experiment was conducted at the Fodder Production Farm, Livestock Research Station (Sri Venkateswara Veterinary University), Lam, Guntur -522034, Andhra Pradesh during the Rabi season 2020. The experimental site is situated at 16º21'N latitude, 80º25'E longitude and altitude of 37 m above mean sea level under sub-tropical climate with maximum and minimum temperatures of 31.37 and 15.82°C, respectively. Experimental crop received a total rainfall of 71.1 mm.

The soil of the experimental field was black clay in nature with pH 8.5 and EC 0.45 dms^{-1} low in Organic carbon (0.42%) medium in available N (288 kg/ha), high in both available P_2O_5 (174 kg/ha) and K_2O (418 kg/ha).

Experiment was laid out in randomized block design. The treatments involved a combination of nitrogen and $ZnSO_4$ as mentioned in Table 1 each treatment combination was replicated thrice.

Table 1: Treatment combinations

Tr. No	Treatment Combinations
T1	80 kg Nitrogen /ha + 10 kg $ZnSO_4$/ha
T2	80 kg Nitrogen /ha + 20 kg $ZnSO_4$/ha
T3	80 kg Nitrogen /ha + 30 kg $ZnSO_4$/ha
T4	100 kg Nitrogen /ha + 10 kg $ZnSO_4$/ha
T5	100 kg Nitrogen /ha + 20 kg $ZnSO_4$/ha
T6	100 kg Nitrogen/ha + 30 kg $ZnSO_4$/ha
T7	120 kg Nitrogen/ha + 10 kg $ZnSO_4$/ha
T8	120 kg Nitrogen/ha + 20 kg $ZnSO_4$/ha
T9	120 kg Nitrogen/ha + 30 kg $ZnSO_4$/ha

Healthy seeds of Baby corn variety G- 5414 of Syngenta Pvt. Ltd. were sown manually by dibbling with spacing of 45 x 25 cm. Nutrients were applied as per treatment description and the sources of N, P, K, Zinc were Urea, Single Super Phosphate (SSP), Muriate of Potash (MOP) and Zinc Sulphate respectively. Full doses P, K, Zn and half dose of N were applied as basal and the remaining half dose of N was top dressed in two equal splits at the knee height stage and tassel emergence stages.

The immature baby cobs were harvested within 2-3 days after silk emergence *i.e* 58 days after sowing (21.01.2021) and subsequently harvested in two pickings. The harvested baby cobs were weighed, de-husked and baby corn yield was recorded.

The fodder samples were oven dried at 60 ºC to constant weight to determine the dry matter (DM) content and were grinded using willey mill to pass through a 1 mm sieve and were stored in to an airtight polythene bag to analyze the quality parameters of the fodder. Crude protein (CP), Crude fiber (CF) and ash were determined by the methods described by [8].

Data obtained was statistically analyzed using the F-test. The significant differences between treatment means were compared with critical differences at 5% level of probability [9].

3. Results

The perusal of experimental data, revealed that application of different levels of Nitrogen and Zinc had significantly improved the yield attributes and in turn the green fodder yield (Table 2) and quality (Table 3) of the of baby corn.

Table 2: Fodder yield attributes of Baby Corn as influenced by the interaction effect of Nitrogen & Zinc.

Tr.	Plant Height (cm)	No. of Leaves	Leaf to Stem Ratio	Baby Corn Yield (kg/ha)	Green Fodder Yield (t/ha)	Dry Fodder Yield (t/ha)
T_1	121.32	9.13	0.44	1932.03	17.1	3.4
T_2	140.03	9.40	0.77	2073.33	33.0	6.3
T_3	151.02	9.87	0.92	2367.20	41.0	8.3
T_4	147.23	9.73	0.76	2309.63	33.1	6.4
T_5	161.55	10.33	0.96	2474.03	42.5	8.7
T_6	178.46	12.00	1.01	2597.47	44.6	8.9
T_7	155.00	10.00	0.94	2396.07	41.0	8.5
T_8	167.99	11.53	0.95	2536.33	42.5	8.5
T_9	177.08	11.73	1.00	2570.37	44.5	8.8
S.Em (±)	1.27	0.19	0.03	20.58	2.3	0.6
CD (P=0.05)	3.82	0.57	0.10	61.71	7.0	1.7

Table 3: Fodder quality of Baby Corn as influenced by the interaction effect of Nitrogen & Zinc

Tr.	Crude Protein content (%)	Crude Protein Yield (kg/ha)	Crude Fiber Content (%)	Crude Fiber Yield (kg/ha)	Ash (%)
T_1	6.46	236	27.8	1017	7.7
T_2	8.00	562	24.7	1735	8.8
T_3	8.83	762	24.4	2108	9.6
T_4	8.08	574	24.7	1756	8.8

T_5	8.94	806	23.8	2145	9.8
T_6	8.98	848	23.6	2230	9.9
T_7	8.88	772	24.4	2122	9.7
T_8	8.92	800	23.8	2135	9.8
T_9	8.96	841	23.7	2225	9.9
S.Em (±)	0.20	44	0.9	116	0.2
CD (P=0.05)	0.60	132	2.6	349	0.7

4. Discussion

At harvest, significantly taller plants and highest No.of leaves were observed in T_6 which received100 kg/ha Nitrogen along with 30 kg/ha $ZnSO_4$ and recorded the highest plant height and maximum no of leaves/plant as 178.46 cm and 12.00 No. respectively. Further, this treatment is statistically at par with the T_9 where it received 120 kg /ha Nitrogen+30 kg/ha $ZnSO_4$ and plant height, No. of leaves/plant, was recorded as 177.08 cm, 11.73 No. respectively. Increment in plant height and No of leaves may be due to the availability of optimum Nitrogen and zinc and stimulating effect of Nitrogen, Zinc on the biological activity of the plant as Nitrogen is the primary building block for plant protoplasm and Protoplasm is the translucent substance that is the living matter in cells which is required for speedy shoot growth. Similar findings were reported by [10, 11, 12].

The leaf to stem ratio of baby corn was the highest at 40 DAS and gradually decreased with advancement in the age of the crop and it significantly influenced by the application of different levels of Nitrogen and Zinc. At harvest (60 DAS) highest leaf to stem ratio (1.01) is recorded with T_6 which received100 kg/ha Nitrogen along with 30 kg/ha $ZnSO_4$ while the lowest value recorded as 0.44 in $T_{1\ and}$ the treatments T3 T_9 T_5 T_7 T_6 T_8 which were on par with each other but provided significantly superior to T_4 and T_2 Leaf to Stem ratio. The increased leaf to stem ratio might be due to the intrinsic effect of Nitrogen on cell division and cell elongation which might have resulted in production of more functional leaves and its sustainability for a longer period of time [13]. Nitrogen is delivered to the stem and leaves as amines etc. Some of these compounds may be immediately exported and enter the leaf cells where they are either stored or used as a source of Nitrogen for the synthesis of protein and other compounds [14]. As nitrogen protects the degradation of proteins through inhibition of protease activity and this extra protein produced with increase in nitrogen supply might have allowed the leaf tissues to grow better and thereby increased the leaf surface for photosynthesis.

Application of 100 kg/ha Nitrogen + 30 kg/ha $ZnSO_4$ produced significantly higher baby corn yield (2597.47 kg/ha) among the treatments. Increase in baby corn yield could be attributed to the favorable effect of applied nitrogen and ZnSO4 physiological and metabolic processes of the plants that ultimately enhanced the yield attributes and thereby baby corn yield. These findings are in confirmity with [15].

Likewise the highest green and dry fodder yields of baby corn (44.6 and 8.9 t/ha) were registered by the application of 100 kg/ha Nitrogen + 30 kg/ha $ZnSO_4$ while the lowest green and dry fodder yields (17.1 & 3.4 t/ha) were obtained with application of 80 kg/ha Nitrogen + 10 kg/ha $ZnSO_4$. The percentage of increase of green and dry fodder yields of T_6 over T_1 was 160 and 161 respectively. However, regarding green fodder yield, T_6 remained statistically at a par with T9, T_8, T_7, T_5 T_3 but differed significantly over T_4, T_2, and T_1. The increase in fodder yields of baby corn might be due to the cumulative effect of substantial improvement in growth characteristics like plant height and dry matter accumulation through efficient metabolic activity and increased photosynthesis at higher levels of Nitrogen and Zinc. Thai indicated that baby corn fodder recovery was not delayed at a higher rate of fertilization [16]. These findings are inline with [17, 18].

The crude protein content & crude protein yield of the baby corn was significantly influenced by various treatments. Highest crude protein content & crude protein yield were recorded as 8.98% and 848 kg/ha respectively with T_6 and it was at par with T_8, T_9, T_7, T_5 T_3. It was observed, 39% of the increase in protein content and 258% in crude protein yield of the green fodder of baby corn with the application of 100 kg/ha Nitrogen + 30 kg/ha $ZnSO_4$ over the application of 80 kg/ha Nitrogen + 10 kg/ha $ZnSO_4$. This might be due to the availability of the Nitrogen which is directly responsible for higher protein content because nitrogen is the primary component of amino acids which constitute the basis of protein [19]. And It is obvious that highest dry matter yields coupled with highest crude protein content might result in the highest highest crude protein yield of baby corn fodder. These results are in conformity with [20] and the similar results reported in maize by [21].

It is observed that there is an increase in crude fiber content of the fodder with an increase in crop age that is from 30 to 60 DAS. This could be ascribed to the accumulation of structural carbohydrates such as hemi cellulose, cellulose, lignin, silica etc. [22]. The highest crude fiber content (27.8%) was observed with application of 80 kg/ha Nitrogen +10 kg/ha $ZnSO_4$ whereas the lowest crude fiber content was recorded as 23.6% with application of 100 kg/ha Nitrogen + 30 kg/ha $ZnSO_4$. The reason for the highest crude fiber content in least fertilized plants might be due to the negative correlation between the nitrogen application and fiber content. And the reduction of fiber fractions indicates an improvement in fodder quality which could be due to the combined application of Nitrogen and Zinc which reduces the soluble carbohydrates content in plant tissue and promotes protein synthesis [23]. Whereas the highest crude protein yield was observed with application of 100 kg/ha Nitrogen + 30 kg/ha $ZnSO_4$ and recorded the value as 2230 kg/ha the increment in crude fiber yield may have occurred due to the highest dry matter accumulation in this treatment.

While coming to the other quality parameter of the fodder, ash content markedly influenced by the various treatments is the reflection of an increase in dry matter production which may be due to more availability of nutrients. The highest ash content (9.9%) was recorded with T_6 and T_9 and lowest (7.7%) was recorded with application of 80 kg/ha Nitrogen +10 kg/ha $ZnSO_4$. Significant improvement in ash content may be due to higher fertility levels which may promote the growth of young root tips by enhancing meristematic activity and Ca can be absorbed only by young root tips in which cell wall of endodermis are still unsupervised [24].

5. Conclusion
From the Results of the present study it was concluded that to obtain maximum yield of baby corn as well as quality green fodder, baby corn can be grown during *Rabi* with application of 100 kg/ha Nitrogen + 30 kg/ha $ZnSO_4$ under irrigated conditions.

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