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Effect of integrated nutrient management on HCN (Hydrocyanic acid) content of forage sorghum (*Sorghum bicolor* L. Moench) during summer season

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Abstract
A field experiment was conducted at the Main Forage Research Station, Anand Agricultural University, Anand in 2012 during summer season to find out the "Effect of integrated nutrient management on growth, content and uptake of nutrients in forage sorghum (*Sorghum bicolor* L. Moench). The field experiment was laid out in randomized block design with four replications. In the experiment there were total twelve treatments comprising of three N and P treatment and nine bio-fertilizers treatments. The results indicated that the treatment T_6 (100-40 N-P kg ha^{-1} + *Azospirillum*) gave significantly highest HCN content (46.68%) and was at par with treatments T_3 (45.41%), T_{12} (44.89%), T_9 (43.90%), T_{11} (43.60%) and T_8 (42.14%). The increase in the HCN content was 15.40% under treatment T_6 over treatment T_2. Significantly lower HCN content T_1 (35.23%) was recorded under treatment T_1 (60-40 N-P kg ha^{-1}). HCN content increased with increasing N levels. In light of the results it is concluded that the application of 100-40 N-P kg ha^{-1} + *Azospirillum* recorded maximum HCN content of forage sorghum variety (GFS-4) along with sustaining soil fertility at harvest under middle Gujarat conditions.

Keywords: INM, N, P, HCN, sorghum, *Azospirillum*

Introduction

Sorghum is indigenous to Africa, and most of prevalent varieties originated on that continent. Sorghum was also grown in India before recorded history and in Assyria as early as 700 BC. Sorghum, besides being fifth most important cereal crop of the world, is also valued for its fodder and stover. Sorghum fodder is suitable for silage and hay making. In India, fodder sorghum is grown in 2.6 m ha mainly in western UP, Haryana, Punjab, Rajasthan and Delhi and fulfills over two third of the fodder demand during *Kharif* season. Forage sorghum plant grows 6 to 12 ft tall and produces more dry matter tonnage than grain sorghum (Pandey KC and Roy AK 2011) [11]. Sorghum is an important forage crop in India. As forage it is fast growing, palatable, nutritious and utilized as silage and hay besides fresh feeding. The yield potential of sorghum is much higher than other forage crops but the production is low (Singh *et al.*, 2016) [13]. The economics of milk production is heavily dependent on the quantity of nutritious forage fed to milch animals. Amongst sources, cultivated fodder contributes to only an extent of 28 per cent. Continuous supply of well-balanced nutritive forage is essential to the milch animals for enhancing milk productivity. Mineral fertilizers play a vital role in improving crop yields but the major challenge is to ensure adequate balance between the different nutrients and support optimal yield. Sorghum (*Jowar*) is a very important *kharif* fodder cultivated on 2.70 lakh hectares (2016-17) and remains palatable and green over an extended period than bajra and maize fodders (Anonymous, 2018). There is a great need to maintain regular well balanced supply of more nutritious feed and fodder in the state. It is an important food, feed, fodder and ration for human, cattle and poultry. Its grains have about 10-12% protein, 3% fat and 70% carbohydrate. In India, the area under sorghum is approximately 11.13 million hectares with an annual production of about 11.62 million tones and an average productivity of 1040 kg ha^{-1}. Sorghum crop exhausts more nutrients than other forage crops and being a cereal crop, its requirement is in higher amount of nitrogen (Crawford *et al.*, 2018). Livestock population of India is around 500 million and is expected to grow at the rate of 1.23 per cent in the coming years. To meet this challenge, concentrated efforts are to be made for reducing the large gap between demand and supply of the fodder in the country. To meet the current level of livestock production and its annual growth in population, the deficit has to be met from either increasing productivity, increasing land area under fodder cultivation or through import. In animal feed supply, cereals have major role and four major cereals *viz.* maize, barley, sorghum and Pearlmillet account for about 44 per cent of the total cereal fodder production.

Integrated nutrient management plays an important role in growth as well as quality of fodder crop production. Nutrient interactions have a role to play in determining the course and outcome of two major issues of interest in fertilizer management-namely, balanced fertilizer input and efficient fertilizer use. The N and P interaction can be termed the single most important nutrient interaction of practical significance. In addition to nitrogen, potassium is the major plant nutrient absorbed and removed by crops in the largest amounts among all essential nutrients. High levels of nitrogen fertilizer or manure will increase the likelihood of prussic acid poisoning as well as nitrate poisoning. Very dark green plant growth often contains higher levels of prussic acid (Dan Under sander, Focus on Forage, 2003). Phosphorus is one of the major essential plant nutrients after nitrogen and is the second most deficient plant nutrients (Munir *et al*. 2004) [8]. Application of phosphorus fertilizer gradually increased plant height, stem diameter, number of leaves per plant, leaf area per plant and fodder yield (Khalid et al. 2003) [6].

Use of bio-fertilizers can have a greater importance in increasing availability of nutrients, fertilizer use efficiency and microbial biomass. Indian soils are characterized as medium status of available nitrogen, available phosphorus and organic carbon and deficient for many micronutrients. Besides their role in atmospheric nitrogen fixation and phosphorous solubilisation, these also help in stimulating the plant growth hormones such as Indole Acetic Acid (IAA), Indole Butyric Acid (IBA), Naphthalene Acetic Acid (NAA), and *Gibberellic Acid* (GA3), providing better nutrient uptake and increased tolerance towards drought and moisture stress. *Azospirillum* and PSB being essential components of organic farming are the preparations containing live or latent cell of efficient strain of nitrogen fixing, phosphate solubilizing or cellulolytic microorganisms used for application of seed, soil or composting areas with the objectives of increasing number of such microorganisms and very significant role in improving soil fertility by fixing atmospheric nitrogen (Mahdi *et al.,* 2010) [9]. Therefore, introduction of efficient strain of "*Azotobacter* and *Azospirillum*" in the soil which is poor in nitrogen, may be helpful in boosting up production and consequently more nitrogen fixation. *Azospirillum* has increased the green and dry fodder yield of 7.8 and 11.3 per cent, respectively (Kumar and Sharma, 2002) [5].

Material and Methods

A field experiment was conducted at the Main Forage Research Station, Anand Agricultural University, Anand is situated at 22^0-35' North latitude, 72^0-55′ East longitude with an elevation of 45.1 metres above the mean sea level. The climate of Anand region is semi-arid and sub-tropical with hot summer and cool winter. In this region, generally monsoon commences in the month of June and retreats by the end of September. Most of the rainfall is received from South-West monsoon currents. July and August are the months of heavy showers. Practically there is no rainfall in winter and summer in almost all parts of Gujarat, except sporadic showers in *rabi* season. The average annual rainfall of this region is about 850 mm. winter starts in the month of November and continues till the middle of February. December and January are the coldest months of the year. The average temperature during the winter varies from 11 to 28 ^{0}C. The summer season usually commences during the second fortnight of February and ends by the month of June. April and May months are the hottest with the temperature rising as high as 45 ^{0}C and occasionally touching 48 ^{0}C. Monthly average wind velocity varies from 1.9 to 7.5 km hr^{-1} with an average annual wind speed of 4.3 km hr^{-1}. Experimental field had an even topography with a gentle slope and good drainage. The soil is representative of the region and is locally known as "*Goradu*" soil. The texture of the soil is sandy loam. The soil is very deep and fairly moisture retentive. It responds well to manuring and suitable to various crops of tropical and sub-tropical regions. The physico-chemical properties of experimental plot were determined by drawing representative soil samples from 0-15 cm depth and analyzed for physical and chemical properties of soil. The field experiment was laid out in a randomized block design with four replications. In the experiment there were total twelve treatments comprising of three N and P treatment and nine bio-fertilizers treatments. The treatments detail includes, that is, T_1: 60-40 (N-P kg ha^{-1}), T_2: 80-40 (Recommended dose of N-P kg ha^{-1}), T_3: 100-40 (N-P kg ha^{-1}), T_4: 60-40 (N-P kg ha^{-1}) + *Azospirillum*, T_5: 80-40 (N-P kg ha^{-1}) + *Azospirillum*, T_6: 100-40 (N-P kg ha^{-1}) + *Azospirillum*, T_7: 60-20 (N-P kg ha^{-1}) + PSB, T_8: 80-20 (N-P kg ha^{-1}) + PSB, T_9: 100-20 (N-P kg ha^{-1}) + PSB, T_{10}: 60-20 (N-P kg ha^{-1}) + *Azospirillum* + PSB, T_{11}: 80-20 (N-P kg ha^{-1}) + *Azospirillum* + PSB and T_{12}: 100-20(N-P kg ha^{-1}) + *Azospirillum* + PSB. Bio-fertilizer was applied as seed inoculums @ 5 ml kg^{-1} seed and through drenching @ 1 liter ha^{-1} at 30 DAS. Fifty percent nitrogen and 100% phosphorus was applied as a basal dose. Remaining 50% nitrogen was applied at 30 DAS. Strain of *Azospirillum* is *lipopherum* (ASA-1) and PSB is *Pseudomonas*. The HCN content in forage plants was determined by the Picric acid method of Hogg and Ah gren (1942). The data statistically analyzed for interpretation of results.

Result and Discussion

HCN (Hydrocyanic acid) content (ppm)

The data pertaining to HCN content in forage sorghum as influenced by integrated nutrient management treatments are presented in Table 1 and graphically illustrated in Fig. 1. The data presented in Table 1 indicated that the effect of integrated nutrient management treatments on HCN content was found significant.

Significantly highest HCN content (46.68%) recorded by T_6 (100-40 N-P kg ha^{-1} + *Azospirillum)* and was at par with treatments T_3 (45.41%), T_{12} (44.89%), T_9 (43.90%), T_{11} (43.60%) and T_8 (42.14%). The increase in the HCN content was under (15.40%) at T_6 treatment over T_2 treatment. Significantly lower HCN content T_1 (35.23%) was recorded under the treatment T_1 (60-40 N-P kg ha^{-1}). HCN content increased with increasing N levels. These results are in accordance with those of Verma (1984) [14] and Sher *et al*. (2012) [12]. Nitrogen application is considered to be essential for growth and regrowth during growing season. However, higher level of nitrogen application may increase prussic acid contents of forage sorghum and ultimately poisoning to animals. Nitrogen application is essential requisite to utilize the available soil and environmental resources effectively. High nitrogen fertilization also leads to increased HCN poisoning in forage sorghum. Hence, it was felt necessary to optimize the dose of FYM and nitrogen application and to study the effect of different organic manures on HCN content and yield of multi-cut forage sorghum (N. Karthika and R. Kalpana 2017) [10]. The perusal of the data revealed that the impact of INM on HCN content was non-significant, nevertheless lowest HCN was noted in RDF only i.e control at both the location. In all the treatment with microbial inoculants numeric increase in HCN content was observed at Bathinda and Ludhiana respectively, but it was within the permissible limit. The numeric increase in HCN content with microbial inoculants might be due to enhanced availability of nitrogen (Kaur *et al*. 2018) [7].

Table 1: Effect of integrated nutrient management on HCN (Hydrocyanic acid) content at harvest of forage sorghum

Sr.no.	Treatments	HCN content (ppm)
T_1	60-40 (N-P kg ha^{-1})	35.23
T_2	80-40 (Recommended dose of N-P kg ha^{-1})	40.45
T_3	100-40 (N-P kg ha^{-1})	45.41
T_4	60-40 (N-P kg ha^{-1}) + *Azospirillum*	39.54
T_5	80-40 (N-P kg ha^{-1}) + *Azospirillum*	41.00
T_6	100-40 (N-P kg ha^{-1}) + *Azospirillum*	46.68
T_7	60-20 (N-P kg ha^{-1}) + PSB	38.79
T_8	80-20 (N-P kg ha^{-1}) + PSB	42.14
T_9	100-20 (N-P kg ha^{-1}) + PSB	43.90
T_{10}	60-20 (N-P kg ha^{-1}) + *Azospirillum* + PSB	39.92
T_{11}	80-20 (N-P kg ha^{-1}) + *Azospirillum* + PSB	43.60
T_{12}	100-20(N-P kg ha^{-1}) +*Azospirillum* + PSB	44.89
S. Em. ±		1.71
C.D. at 5%		4.92
C.V. %		8.18

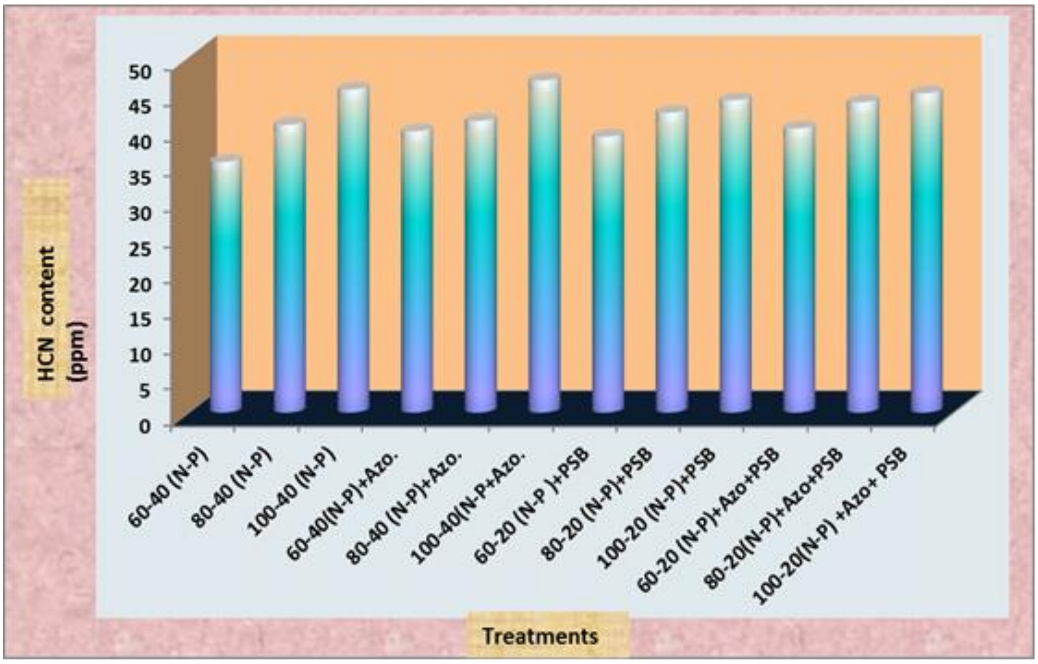

Fig 1: Effect of integrated nutrient management on HCN content (ppm) at harvest

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