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PERFORMANCE OF NITROGEN AND ZINC LEVELS ON GROWTH, YIELD, QUALITY AND ECONOMICS OF FODDER PEARL MILLET UNDER DRY LAND CONDITION

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GFY (Green fodder yield),
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EC (Electrical conductivity),
NFE (Nitrogen free extract),
TDN (Total digestible nutrient),
EE (Ether extract),
SSP (Single super phosphate).

ABSTRACT

A field experiment entitled "Performance of nitrogen and zinc levels on growth, yield, quality and economics of fodder pearl millet under Dry land condition" was conducted during kharif season of 2015-16 at the farm Of Agronomy in Bhagwant University, Ajmer (Rajasthan). The soil of experimental plot was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and in available nitrogen and low in available phosphorus but having fairly rich status of available potassium. The experiment was laid out in Factorial randomized block design, replicated thrice with twenty treatments. The gross and net plot size was 5.5 x 4.0 m^2 and 3.5 x 2.5 m^2, respectively. The various treatments tried under study showed no significant influence on the initial and final plant stands by the various dose of Nitrogen and Zn. The height of plants, number of functional leaves, leaf area, leaf area index, total dry matter accumulation, number of tillers, per plant leaf: stem ratio and chlorophyll content of leaves, were recorded higher with the application of N_{130} than the rest of treatments. The green and dry fodder yield showed significant response with increasing N levels up to 105 N ha^{-1} and further increase in N level to 130 kg/ha though maximized the green and dry fodder yields. The quality parameters *viz.*, crude protein and ether extract increased significantly with increasing nitrogen dose up to 130 kg/ha,. While crude fiber and ash content were found non-significant with nitrogen application up to the highest level. The N and Zn content both the cuttings and their total uptake also improved with increasing N levels in fodder pearl millet. Application of 25 kg $ZnSO_4$ ha^{-1} increased green fodder and dry matter yields significantly over control and 20 kg $ZnSO_4$ ha^{-1}. Also, quality parameters and N, Zn status of dry matter improved with increasing dose of $ZnSO_4$ up to 50kg/ha compared to rest doses of Zn. The economic evaluation of treatment indicates that net monetary returns and B:C ratios raised with increasing the level of either of the (Nitrogen or Zn) realized maximum values of total green fodder yield was recorded by high dose of Nitrogen and Zn (384.75 and 352.68 q ha^{-1} respectively) and net returns (61440 ₹ ha^{-1}).

INTRODUCTION

Pearl millet (*Pennisetum americanum* L.) is traditionally a dry land crop, which have the capacity to tolerate the higher deficit of the water, commonly known as Bajra, Bajri, Sajja, Combo, or Kambam, cultivated mostly in arid and semi-arid regions, characterized by low rainfall, sandy soils with low fertility, where other coarse cereals such as sorghum and maize fail to produce assured yields.

This crop is not only cultivated for grain, but is also valued for its Stover and fodder purpose. The Stover of pearl millet forms an important source of fodder (particularly in low rainfall regions) accounting for 40-50% of the dry matter intake and is often the only source of feed in dry months. The dual purpose nature of pearl millet offers both food and fodder security in the arid and semi-arid regions of the country (Ramesh *et al.*, 2006). In India, the total area under cultivated green fodder of Pearl millet is 0.9 million hectares and the green fodder productivity is 21.34 tonnes per hectare (Anonymous, 2014 a). Rajasthan stands first both in area (46 lakh ha) and production

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(28 lakh tonnes) of pearl millet in the country. Out of 9.43 m ha of pearl millet area in India, about 4.38 m ha is cultivated in Rajasthan, eighty per cent of which occurs in western Rajasthan, Constitutes about 50% area and 42% of production of pearl millet in the country (Anonymous, 2013 b). Pearl millet as fodder crop has some additional advantages over sorghum and maize because of two reasons – first the green fodder of bajra has high crude protein content (9.9 to 14 %), second, its green fodder can be safely fed to cattle at all stages of growth because of absence of hydrocyanic acid. It also has high tolerance to drought and temperature as compared to maize and sorghum. The cultivation of pearl millet for fodder purpose has recently been emphasized due to its profuse tillering, multicut nature, absence of poisonous 'prussic acid' and good performance even on poor soils. Pearl millet as the poor man's crop is favorably productive under optimum management. However, the green fodder production potential depends on physiological growth stage and cutting at optimum stage during the growing season. Multicut nature of the crop ensures the forage supply over a long period of time, reduced cost of cultivation and many other benefits.

The state of Rajasthan has 13.30 million cattle, 12.90 million buffaloes, 9.07 million sheep, 21.60 million goats (Anonymous, 2013 b).To sustain this cattle wealth as well as its productivity; a large quantity of fodder is required throughout the year. The efficiency of milch as well as draught animals largely depends upon the supply of quality of ration in which green fodder plays a vital role. In the recent years, shortage of fodder has remained the burning problem of Rajasthan state which calls for the attention of researchers to initiate efforts that can ensure regular fodder supply for development of dairy farming and improving the cattle wealth. Nitrogen is an essential nutrient for plant growth and development. Nitrogen is a very important constituent of cellular components. Alkaloids, amides, amino acids, proteins, DNA, RNA, enzymes, vitamins, hormones and many other cellular compounds contain nitrogen as one of the elements. An adequate supply of nitrogen is associated with vigorous vegetative growth and deep green colour. Also Nitrogen is an integral part of chlorophyll ($C_{35}H_{72}O_5N_4Mg$) and to improve the yield and quality of forage pearl millet. Judicious and appropriate use of fertilizer not only increases yield but also improves quality of forage especially protein contents (Ayub *et al.,* 2007).

Generally, pearl millet has been known for growing under low N management (Gascho *et al.,* 1995) but, several studies showed that N application can increase millet production efficiency (Singh *et al*., 2010). Though, zinc plays significant role in various enzymatic and physiological activities of plant. Zinc catalyses the process of oxidation in plant cell and is vital for transformation of carbohydrate regulate the consumption of sugar, increase source of energy for the production chlorophyll, aids in the formation of auxin which produce more plant cell and more dry matter, then in turn will be stored in seed as a 'sink and promote absorption of water. Zinc is an essential micronutrient required for growth and development of the higher plants (Kochian,1993 & Marschner, 1995), and is involved in membrane integrity, enzyme activation, and gene expression (Kim *et al.,* 2002). It promotes biosynthesis of growth hormone, the formation of starch, and grain production and maturation (Brady and Weil, 2002). It is well a known fact that zinc is now considered as fourth most important yield-limiting nutrient after nitrogen, phosphorus and potassium (Maclean *et al.,* 2002). Its importance for pearl millet productivity is similar to that of major nutrients. The crop requires small amount of Zn for their normal growth but its application is high due to low fertilizer use efficiency, therefore, a considerable amount of applied Zn remains in soil which can be utilized by subsequent crops. Under dryland conditions reduced soil moisture in surface soil layer reduce zinc adsorption and may cause zinc deficiency. Cereal crops are generally the most susceptible to zinc deficiency and show a high response to zinc fertilization. Agronomic approaches such as application of Zn-containing fertilizers appear to be a rapid and simple solution to address the Zn deficiency in crop and human health.

Recent reports suggest that zinc is most commonly deficient (less than 0.5ppm) in most pearl millet growing areas in Rajasthan. Zinc deficiency can be corrected by applying zinc sulfate to the soil before the final ploughing. Singh (2009) reported that 49% soils in India are deficient in available Zn and the application of Zn is reported to increased cereals yield by 6.3% – 9.3%. Gulati and Yadav (2014) also opined that about 80-85% soil sample tested were found Zn deficient in light soils of western Rajasthan. In most trials in India efficacy of a micronutrient is generally tested in the presence of NPK. A positive NPK x Zn interaction was observed in pearl millet, rice, maize, wheat, groundnut, and soybean. Synergistic effects of Zn x N interaction (Boawn *et al.* 1960, Gupta 1995, Lakshman *et al.* 2005 and Sajad *et al.* 2014) are mainly attributed to increased availability of Zn in soils due to acid forming effect of Nitrogen. Keeping the above facts in view, the present study entitled "Performance of Nitrogen and Zinc levels on growth, yield quality and Economics of fodder Pearl millet under dry land condition*)*" was carried out during *kharif*, 2015 with the following objectives:- (1) To find out the effects of nitrogen and zinc levels on growth, yield and quality of pearl millet. (2) To assess the suitable dose of nitrogen and zinc for pearl millet. (3) To assess the economics of different treatments. An attempt has been made to cite all available literature on related work on fodder pearl millet but due to paucity of adequate published information, research work on other crops have been also reviewed. Besides review of literature on "Performance of Nitrogen and Zinc levels on growth, yield and quality of fodder pearl millet under dry land condition". Similar findings on other crops have been included.

Effect of nitrogen:-Effect on growth characters: Pathan *et al.* (2010) a field studies were conducted in Maharashtra to investigate the effects of 3 N levels (50, 75 and 100 kg ha^{-1}) on the seed yield of 8 forage pearl millet cultivars. Result showed that maximum values of growth attributes, i.e. number of tillers per plant (4.46), plant height (404.89 cm) and plant population per meter row length (6.78) were recorded higher with increase nitrogen level. Mahdi *et al.* (2011) at Kashmir on fodder maize reported that application of 120 kg N ha^{-1} significantly increased all the growth components *viz.*, plant height, leaf-stem ratio, dry matter production, chlorophyll content and number of functional leaves $plant^{-1}$ at different crop growth periods of fodder maize during two years of experimentation. Shahin *et al.* (2013) while working in fodder pearl millet at Ain Shams University at Shalakan, (Kalubia) reported that adding 75 kg N/fed, the number of leaves m^2 increased in the second season of the growth and combined results during in the first, second, and third cuts. These increases were 267.33%, 154.07%, 113.70%, 148.59%, 138.39%, and 113.47% in the second season of growth and combined results in the three cuts, respectively, as compared with the control treatment (without addition). Further they opined that with increasing nitrogen fertilization rates from zero up to 45 kg N/fed, number of tillers/m^2 increased and then decreased as nitrogen fertilization increased up to 60 or 75 kg N/fed. Though, plant height and number of leaves m^2 increased significantly up to 60 kg N/fed dose. Singh *et al.* (2014) reported at Hisar that Plant height of pearl millet increased significantly with increase in nitrogen from 0 to 120 kg ha^{-1} The highest plant height (92.73 cm) was observed with 120 kg Nha^{-1} and this was significantly superior to the lower levels of nitrogen.Singh *et al.* (2015) reported at Hisar that increasing level of N application from 0 to 40, 80 and 120 kg ha^{-1} increased the plant height of maize. The minimum plant height (104.11 cm) was observed at control and maximum (120.03 cm) at 120 kg N ha^{-1}.

Effect on Yield: Mahdi *et al.* (2010) opined at Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir (J&K) that green and dry fodder yield of maize as well as their pooled yield over two years showed significant and consistent increase with increase in the levels of nitrogen from 60 to 120 kg ha^{-1}. Mahdi *et al.* (2011) at Kashmir on fodder maize reported that application of 120 kg N ha^{-1} significantly increased green and dry fodder yield noted marked increase with increase in nitrogen rates from 60 to 120 kg ha^{-1}. Singh *et al.* (2012) indicated that the application of 90 kg N ha^{-1} in pearl millet produced 53.2, 25.9 and 11.9 per cent higher dry matter yield over 0, 30 and 60 kg N ha^{-1}, respectively. Manjunath *et al.* (2013) conducted trial in fodder sorghum at University of Agricultural Sciences at Dharwad (Karnataka) and reported that the green fodder yield were increased significantly with successive increase in nitrogen levels up to 300 kg N ha^{-1} in all the cuts. Application of 300 kg N/ha resulted total green fodder yield (179.63 t ha^{-1}) was significantly higher by 38.7, 24.7 and 11.6 per cent more over 120, 180 and 240 kg N ha^{-1}, respectively. Khan *et al.* (2014) at Agricultural Research Farm of Agricultural University Peshawar (Pakistan) reported in fodder maize that higher fresh weight (2375.9 kg ha^{-1}) was recorded when nitrogen was applied at the rate of 180 kg N ha^{-1} followed by 150 kg N ha^{-1} with fresh weight (1771.3 kg ha^{-1}) and 120 kg N ha^{-1} with fresh weight (1490.7 kg ha^{-1}) where 90 kg N ha^{-1} resulted in lowest fresh weight (1101.9 kg ha^{-1}). Similarly, higher dry weight (952.8 kg ha^{-1}) was recorded when nitrogen was applied @ of 180 kg N ha^{-1} followed by 150 kg N ha^{-1} with dry weight (727.8 kg ha^{-1}) and 120 kg N ha^{-1} with dry weight (684.3 kg ha^{-1}), While lower nitrogen rate (90 kg ha^{-1}), resulted the lowest dry weight (538.9 kg ha^{-1}).

Somashekar *et al*. (2014) a field experiment was conducted at Zonal Agricultural Research Station Mandya (Karnataka) on multicut fodder sorghum and reported that application of 60 kg N ha^{-1} recorded significantly higher dry matter yield (18.23 t ha^{-1}) as compared to 15 kg N ha^{-1} (13.80 t ha^{-1}) and was on par with 45 and 30 kg N ha^{-1} (17.60 and 17.04 t ha^{-1}, respectively) on pooled data basis. Application of 30 kg N ha^{-1} recorded significantly higher green fodder yield (76.46 t ha^{-1}) as compared to 15 kg N ha^{-1} (65.19 t ha^{-1}) and was on par with 45 and 60 kg N ha^{-1} (77.27 and 80.26 t ha^{-1}) on pooled data basis. Ullah *et al.* (2015) reported at Gomal University, Dera Ismail Khan, Pakistan that fodder maize plants received the 240 kg N ha^{-1} produced maximum green fodder yield (45.35 t ha^{-1}) followed 280 and 200 kg N ha^{-1} (45.23 and 41.66 t ha^{-1}, respectively). However, minimum green fodder yield (16.04 t $ha^{-1)}$ was recorded in control treatment followed by 80 (25.38 t ha^{-1}) and 120 kg N ha^{-1} (30.30 t ha^{-1}).

Effect on Quality: Sheta *et al.* (2010) a Field experiment was conducted on loamy sand soil of Anand (Gujarat) to study the effect of different levels of N, K and S on forage pearl millet. Application of higher N rate (150 kg N ha^{-1}) increased crude protein content (CPC) and crude protein yield and decreased acid detergent fiber (ADF) or neutral detergent fiber (NDF). Tiwana *et al*. (2012) reported that application of nitrogen increased crude protein content up to the highest dose (150 kg N ha^{-1}). The crude protein content under irrigated conditions increased from 7.05 in control to 9.46% with 150 kg N ha^{-1} and Increase in crude protein with each increment in nitrogen dose might be due to increased absorption of nitrogen from the soil. Manjunath *et al.* (2013) reported in fodder sorghum at University of Agricultural Sciences, Dharwad that crude protein content increased significantly with increased nitrogen levels up to 300 kg N ha^{-1} from all the cuttings while the crude fiber content decreased significantly with increase in nitrogen levels at all the cuttings. Whereas total ash and ether extract content and yield increased significantly with increased nitrogen levels. However, nitrogen free extract decreased significantly with increase in N level up to 240 kg ha^{-1}. Kumar & Chaplot (2015) a field experiment was conducted on clay loam soils of the Instructional Farm, Rajasthan College of Agriculture, Udaipur to study the effect of fertility levels viz., control, 50 per cent recommended dose of fertilizer (RDF), 75 per cent RDF and 100 per cent RDF (80 kg N+40 kg P_2O_5+40 kg K_2O ha^{-1}) on quality of multi-cut fodder sorghum genotypes. The result indicated that application of 100 per cent RDF significantly increased content and uptake of crude protein, crude fiber, and mineral ash another extract over lower fertility levels in both the cuts. While application of higher fertility levels caused significant reduction in TDN and NFE content in dry fodder which were highest in unfertilized control.

Nutrient content and uptake: Somashekar *et al.* (2014) reported that a field experiment was conducted at Zonal Agricultural Research Station, Mandya (Karnataka) on multicut fodder sorghum. Nitrogen uptake was significantly influenced with nitrogen levels. Pooled data indicated that Among nitrogen levels, application of 60 kg N ha^{-1} recorded significantly higher total nitrogen uptake (242.44 kg ha^{-1}) which was at par with 45 kg N ha^{-1} (227.67 kg ha^{-1}) but significantly superior over 30 and 15 kg N ha^{-1} (220.11 and 157.78 kg ha^{-1}, respectively). Singh *et al.* (2015) reported at Hisar on maize that nitrogen uptake by maize increased significantly at all the levels of N application over control. The extent of increase observed was 41.64, 113.70 and 155.29 per cent over control, with the respective application of 40, 80 and 120 kg N ha^{-1}.

Effect of zinc:-Effect on growth characters: Meena *et al.* (2010) reported that the production performances of newly developed genotypes of forage sorghum three level of zinc indicated that the maximum growth attributes along with monetary return were attained with highest level of zinc i.e. 20 kg Zn ha^{-1}.Mahdi *et al.* (2011) at Kashmir on fodder maize reported that all the yield contributing parameters *viz.*, plant height, chlorophyll content, number of functional leaves $plant^{-1}$, stem diameter, LSR and final yield recorded remarkable increase with zinc application @ 10 kg ha^{-1} over no zinc application over two years of study. Anil Kumar *et al*. (2012) conducted a experiment in pearl millet with three levels of $ZnSO_4$ *i.e.* control (T_1), 10 kg $ZnSO_4$ as basal + 0.5 per cent as foliar spray 30 days after sowing (T_2) and 20 kg $ZnSO_4$ ha^{-1} as basal (T_3)]. The result revealed that dry fodder yield increased to the tune of 15.5 and 10.7 per cent by T_3 and T_2 treatments, respectively, compared to control (T_1). The results also indicated that basal application of $ZnSO_4$ was slightly better than combination of basal and foliar.

Effect on Yield: Mahdi *et al*. (2010) showed that the soil application of $ZnSO_4$ @ 10 kg ha^{-1} recorded discernible increase in green, dry fodder over no application of $ZnSO_4$ during both the year and pooled data basis. Anil Kumar *et al.* (2012) reported that the increase in green forage yield in pearl millet (HHB 197) with 10kg $ZnSO_4$ as basal treatments was 9.6 and 17.9 per cent higher over 5 kg $ZnSO_4$ and control respectively. Deo *et al.* (2013) a field experiments was conducted at ARS, Durgapura on pearl millet and reported that application of 30 kg $ZnSO_4$ ha^{-1} at site I gave significantly higher stover yield (92.11q ha^{-1}) of pearl millet over all the lower levels and at par with higher level.

Effect on quality parameters: Jain and Dahama, (2005) revealed that application of 6 kg Zn ha^{-1} to wheat significantly improved the protein content in succeeding pearl millet (*Pennisetum glaucum* L.) over control, while application of Zn at 12 kg Zn ha^{-1} significantly improved Zn uptake by pearl millet over lower levels. Patel *et al*. (2007) showed that soil application of 25 kg $ZnSO_4$ gave significantly higher crude protein yields than control in maize crop. Sutaria *et al*. (2013) reported that Protein content and yield of forage sorghum were increased progressively with the increasing Zn levels.

Zn content and uptake: Kumar *et al*. (2010) conducted a field experiment on sorghum was at instructional farm, Rajasthan college of agriculture, MPUAT Udaipur reported that application of RDF+25 kg $ZnSO_4$ increased zinc uptake by the crop. Deo *et al*. (2013) a field experiments was conducted at ARS, Durgapura on pearl millet treatment consisted of 0, 5, 10, 15, 20, 25, 30 and 35 kg zinc sulphate ha^{-1}. Zn uptake by pearl millet crop increased with increasing levels of $ZnSO_4$ .The increase in Zn uptake with 35 kg ha^{-1} was 78.78, 66.71, 64.14, and 57.36 at the five sites respectively.

Interaction effect: Cakmak *et al.* (2010) reported in durum wheat that nitrogen nutrition of plants appears to be synergistic with zinc, which may leads to increase in many physiological and molecular activities which in turn improve yield attributing characters. Asif *et al*. (2013) A field experiment was conducted at Faisalabad (Pakistan) to evaluate the impact of different nitrogen and zinc sulphate levels on the phenology, yield and quality of maize. Maize hybrid "Pioneer (SS-2525)" was subjected to four rates of N (0, 200, 250 and 300 kg ha^{-1}) and $ZnSO_4$ (0, 9, 18 and 27 kg ha^{-1}) reported that Interaction between N and $ZnSO_4$ was also found to be significant for plant height. The maximum plant height (242.3 cm) was recorded from N_3Zn_3 (300 kg N+27 kg $ZnSO_4$) which was statistically at par (237.3 cm) with N_3Zn_2 (300 kg N+18 kg $ZnSO_4$). Minimum plant height (186.6 cm) was recorded in those plots where N and $ZnSO_4$, were not applied. Sajad *et al.* (2014) reported at Pakistan that CPY significantly escalated with increasing rates of nitrogen and zinc applied to maize fodder. Different nitrogen levels augmented CPY of maize fodder. Similarly, zinc applied to maize fodder showed pronounced effect. Their interaction was found synergistic for improving CPY of maize. The highest crude protein yield (1.69 t ha^{-1}) was recorded with the treatment comprising N @ 150 kg ha^{-1} with 10 kg h^{-1} Zn and the lowest CPY (0.40 t ha^{-1}) was found in control, where significant improvement in CPY over the control was observed with combinations of 50, 100 and 150 kg N ha^{-1} and 5 and 10 kg Zn ha^{-1} with a control treatment. As far as zinc supply concerned, TDN showed non-significant improvement. Similarly, their interaction demonstrated synergistic effect showing same trend of TDN increment. The maximum TDN (47.16 %) were recorded with the treatment comprising N @ 100 kg ha^{-1} with 10 kg ha^{-1} Zn, while minimum TDN (45.84 %) were observed in the treatment where lowest rates of nitrogen and zinc (N @ 50 kg ha^{-1} + Zn @ 5 kg ha^{-1}) were applied.

MATERIALS AND METHODS

A field experiment entitled "Performance of Nitrogen and Zinc levels on growth, quality and economics of fodder pearl millet under dry land condition' in **(**2015-16). The details of the materials used and methods adopted during the course of investigation are outlined in this chapter.

Details of experimental material: Experimental site: The present investigation was carried out on the plot number 23 in the field of Bhagwant University Agriculture farm, Ajmer, during 2015-2016. Topography of the field was fairly uniform and level. The soil was medium black cotton soil belonging to *vertisols*.

Soil: Before starting the field experimentation in 2015-16, the soil was analyzed for pH, EC, organic carbon status and available nutrients contents. In order to evaluate the physico-chemical properties, soil samples from 0-30 cm depth were taken from five random spots of the experimental field prior to layout and representative composite sample was prepared by mixing and processing of all soil samples together. The homogeneous composite soil sample was subjected to mechanical, physical and chemical analysis. The results of these analyses along with methods used for determination are presented in Table 3.3. It is apparent from data that the soil of the experimental field was loamy sand in texture, alkaline in reaction, poor in organic carbon with low available nitrogen and phosphorus, medium in potassium and low in zinc content Table 1. The soil of experimental plot was loamy sand in texture. Soil was slightly alkaline in reaction. The fertility status of the soil indicates that the soil was medium in organic carbon, medium in available nitrogen and available phosphorus and moderately high in available potassium. The bulk density of the soil is 1.22 Mg $m^{-3.}$

Cropping history of experimental field: The cropping history of the experimental plot for last five years is presented in Table 2. Plot number 23 on the agriculture farm of Bhagwant University.

Climate and weather conditions:- Ajmer is situated in the sub-tropical zone at the latitude of 24°32' North longitude of 67°02' East. The altitude of the place is 307.41 meter above mean sea level. The climate of Ajmer is semi-Arid and characterized by three distinct seasons' *viz.*, hot and dry summer from March to May, warm and rainy monsoon from June to October and mild cold winter from November to

February. Most of the rain received from south-west monsoon during June to October. Ajmer received average annual rainfall of about 750 mm, out of which 80 per cent of rainfall is received in *Kharif* season (July-September) by the southwest monsoon. During summer, the maximum temperature may go as high as 37^{0}C while in the winter it may fall as low as 5^{0}C. This region is prone to high wind velocity and soil erosion due to dust storms in summer.

Table 3 shows that maximum temperature ranged between 35.40 ^{0}C and 35.45^{0}C during the crop growing season were recorded in the 20th and 22th standard meteorological weeks Likewise, the minimum temperature between 10.3^{0}C and 10.6^{0}C were recorded in the 50th and 52nd standard meteorological weeks, respectively. During crop season, total 750.0mm rainfall received. The maximum relative humidity ranged between 58 and 87.0 per cent during the crop growing

Table 1. Mechanical and chemical composition of soil of experimental plot

S. No.	Particular	Value	Analytical method adopted
A.	Mechanical composition		
1	Sand (%)	20.22	Bouyoucos Hydrometer Method(Piper, 1966)
2	Silt (%)	10.9	
3	Clay (%)	17.5	
4	Textural class	Loamy sand	
B.	Chemical composition		
1	Available nitrogen (kg ha^{-1})	132.10	Alkaline permanganate method (Subbiah and Asija, 1956)
2	Available phosphorus (kg ha^{-1})	16.56	Olsen's method, (Jackson, 1967)
3	Available potassium (kg ha^{-1})	160.56	Flame emission Spectro-photometer (Jackson, 1967)
4	Organic Carbon (g kg^{-1})	2.7	Walkley and Black's rapid titration method(Jackson, 1967)
5	Soil Ph	8.4	Beckman's glass electrode pH meter (Jackson, 1967)
6	Electrical conductivity (d Sm^{-1})	1.24	Solu-bridge (Richards,1954)
C.	Soil Physical composition		
1.	Bulk density (Mg m^{-3})	1.22	Core sampler method (Piper,1966)

Table 2. Cropping history of experimental field

Year	Season	
2010-11	*Kharif / Rabi*	Summer
2011-12	Sorghum crop	Fallow
2012-13	Wheat	Fallow
2013-14	Bajara	Fallow
2014-15	Guar	Fallow
2015-16	Maize	
2010-11	Present experiment	

Table 4.Treatments details along with symbols used

S.NO.	Treatment	Symbols
A	Nitrogen level	
a.	Control	N_0
b.	45 kg N/ha	N_{45}
c.	65 kg N/ha	N_{65}
d.	105kg N/ha	N_{105}
e.	130 kg N/ha	N_{130}
B	Zinc level	
a.	Control	Z_0
b.	20 kg $ZnSO_4$/ha	Z_{20}
c.	25 kg $ZnSO_4$/ha	Z_{25}
d.	50 kg $ZnSO_4$/ha	Z_{50}

Experiment layout:- The plan of experiment and other details are given as under:

1.	Season	*Kharif* 2015
2.	Crop	Pearl-millet
3.	Variety	FBC-16
4.	Design	Factorial randomized block design
5.	Total no of treatments	5x4
6.	No. of replication	3
7.	Total no. of plots	60
8.	Gross plot size	5.5 x 4.0
9.	Net plot size	3.5 x 2.5 m^2
10	Crop geometer	25 cm row spacing
11	Fertilizers (a) Nitrogen (b) Zinc	As per treatment through Urea As per treatment through Zinc sulphate

Table 5. Crop and their varieties used for experimentation

Crops	Botanical name	Varieties
Pearl millet	*Pennisetum americanum* L.	FBC-16

season were recorded in the 22th and 33th standard meteorological weeks.

Experimental Details: Experimental design and treatments details: The present investigation entitled "Performance of Nitrogen and Zinc levels on growth, yield, quality and economics of pearlmillet under dryland condition" was laid out in Factorial Randomized Block Design (FRBD) with three replications. The treatments details and other relevant details are given in Table 4 and plan of layout is depicted in Fig. 1.

Seed material: In the present experiment, crop and its variety used for experimentation are presented in Table 5.

Salient features of fodder Pearl millet variety- FBC-16: The variety has been bred by PAU, Ludhiana and notified for cultivation in the entire northwest India. This is a multicast variety, resistant to major diseases. The variety has low concentration of oxalates and high voluntary dry matter intake by the animals. The green fodder yield potential is 70–80 /ha. (CVRC Notification no. 1178(E) dated 20th July 2007).

Details of crop rising: The different package of practices followed for crop rising are given below.

Field preparations: The experimental field was prepared by cross harrowing followed by planking. The experiment was laid out as per plan.

Fertilizer application: Nitrogen 1/3rd dose and full dose of $ZnSO_4$ was applied before sowing. Remaining 2/3rd dose of N was applied in two equal splits *i.e.* 1/3rd at 25 (DAS) and rest 1/3rd one week after first cutting (50 DAS). Phosphorus @ 40 P_2O_5 kg ha^{-1} were given as basal through single super phosphate.

Seed treatment: The seed was treated with Thiram @ 3.0 g/kg seed just before sowing to ensure protection from soil and seed borne diseases followed by imidaclorprid @ 3 g/kg seed against termite controlled other insect protection measure.

Growth attributes: For analysis of growth characters, five plants randomly selected in each plot from the sampling rows were tagged properly.

Plant population: The number of plants per meter row length was recorded from three randomly selected spots in each plot at 25 DAS and at harvest. These were averaged to work out number of plant per meter row length.

Plant height: The height of five plants tagged permanently from each plot was measured from the ground surface (base of stem) up to base of fully expanded leaf with the help of meter scale at 45 and 90 DAS, and the average value of these five plants was recorded as mean plant height (cm).

Number of tiller per plant: The number of tiller per plant was counted at 45 DAS and at harvest and average was worked out.

Leaf: stem ratio: Leaf dry weight and stem dry weight was taken separately and L: S ratio of the same five plants was recorded at 45 DAS and at final harvest.

Leaves: The number of leaf per plant of the same five plants was counted at 45 DAS and at harvest and average was worked out.

Chlorophyll content: Chlorophyll content of leaves was worked out at 45 and 90 DAS by Hiscox and Israelstem (1979), demonstrated that the absorption spectrum (600-680 nm) for chlorophyll extracted in DMSO was virtually identical to that for extracted in 90 per cent acetone. Accordingly chlorophyll was extracted in DMSO and transmittance was recorded with spectro-photometer at 645 and 663 nm. Arnon's equation (1949) was used to work out chlorophyll content as here under:

Seed and sowing: The seed of fodder pearl millet variety FBC- 16 was shown on 18th July, 2015 using 12 kg seed ha^{-1} at the depth of 2-3 cm manually in the furrow already opened by hand drawn seed drill. Sowing was done keeping row to row spacing 25 cm and plant to plant 3-5 cm apart.

Chronological record of crop rising

Table 6. The chronological record of crop rising

S. No.	Particulars	Date	Remarks
1.	Ploughing and planking	18.07.2015	Tractor drawn harrow and planker
2.	Layout of experimental field	19.07.2015	Manually
3.	Nitrogen and $ZnSO_4$ application(Basal)	19.07.2015	Manually
4.	Sowing	20.07.2015	By hand operated wooden plough in furrow
5.	Gap filling & Thinning	08.08.2015	Manually
6.	Weeding & hoeing	15.08.2015	Manually
7.	Application of nitrogen as per treatment at 17.08.201per treatment 25 DAS (top dressing)	22.08.2015	Manually
8.	Application of nitrogen as per treatment 17.08.201per treatment (top dressing)	11.09..2015	Manually
9.	1st Irrigation	17.09.2015	Sprinkler for 3 hours
10.	2nd irrigation	23.09.2015	Sprinkler for 3 hours
11.	3rd irrigation	30.09.2015	Sprinkler for 3 hours
12.	4th irrigation	07.10.2015	Sprinkler for 3 hours
13.	1st cutting	14.09.2015	45 DAS
14.	2nd cutting	21.10.2015	45 day after 1st cutting

Observation for treatment evaluation: In order to study growth, yield and quality characters necessary periodical observations were taken as per plant. The details of particulars these observations are as under

Thinning and gap filling: In order to maintain the plant to plant spacing thinning of overcrowded plants and gap filling in guppy stands was done manually at 15 days after sowing.

Weeding and hoeing: One hoeing through weedier cum mulcher at critical crop stage *i.e.* 25 DAS was done very effective to control the season weeds.

Irrigation: Four Irrigation was applied to the crop during the dry spell and the respective dates shown in Table 6.

Plant protection: In fodder pearl millet dependence on chemicals for control of insect-pest and diseases is not preferred. Clean cultivation and seed treatment are adopted for reducing the damage from insect-pest and diseases.

$$\text{Chlorophyll "a" (mg g}^{-1}\text{ fresh weight of leaves)} = \frac{(12.7 \times A_{663}) - (2.69 \times A_{645})}{1000} \times \frac{\text{Volume of DMSO}}{\text{Weight of leaf sample}}$$

$$\text{Chlorophyll "b" (mg g}^{-1}\text{ fresh weight of leaves)} = \frac{(22.9 \times A_{645}) - (4.65 \times A_{663})}{1000} \times \frac{\text{Volume of DMSO}}{\text{Weight of leaf sample}}$$

$$\text{Total Chlorophyll (mg g}^{-1}\text{ fresh weight of leaves)} = \text{Chlorophyll 'a'} + \text{Chlorophyll 'b'}$$

Total chlorophyll content was worked out by adding chlorophyll "a" and chlorophyll "b" as under:

Fodder Yield:-Green fodder yield: For green fodder, Crop was harvested at 45 DAS and 90 DAS. First two rows as half metre from either side as border from each plot were harvested. Then crops were harvested from each net plot area individually, tagged and weighed. Weight was recorded and expressed in kg ha^{-1}. Then converted into green fodder yield (q ha^{-1}). Fodder samples from each plot were taken for analysis of quality parameters.

Dry matter yield: Dry matter yield (q ha^{-1}) was taken from samples of fresh weight after complete drying or on the basis of the moisture content in biomass at cutting, putting sample in oven at 72^0C for 24 hours.

Forage quality parameter: The quality was taken in term of crude protein, crude fiber, ether extract, ash and TDN of the oven dried samples taken at each cutting. The dry samples were grind and used for the determination of the quality parameter as per standard method given in the following paragraphs.

Crude protein: Crude protein content was determined by multiplying the nitrogen content of dry fodder with factor 6.25 as described by A.O.A.C. (1970).

Crude protein content = Nitrogen content (%) x 6.25

Crude fiber: Crude fraction is that fraction of total carbohydrate which is not digested after successive boiling with dilute acid and alkali. It consists of cellulose, hemicelluloses and lignin and it is supposed to indigested. It is based on treating fat free sample with successively with dilute (1.25%) acid and alkali. (A.O.A.C. 1970).

Crude fiber (%) = $\frac{w_2 - w_3}{w_1}$ x100

Weight of sample
= W_1
Weight of silica crucible + residue
(After oven drying *i.e.* before ashing) = W_2
Weight of silica crucible + residue (After ashing) = W_3

Ether extract: When a feed sample is treated with petroleum ether in soxhelat extraction assembly, it dissolves fats and fatty substance in the sample, on evaporation of petroleum ether, ether extract obtained. (A.O.A.C 1970).

Ether extract (%) = $\frac{w_3 - w_2}{w_1}$ x100

Weight of dry sample = W_1
Weight of flask = W_2
Weight of fat and oil after extraction = W_3
Weight of Ether extract = W_3 - W_2

Total ash (mineral matter): Ash is inorganic or mineral component a feed sample left after complete ignition of a biological material at 600^0C in muffle furnace on ignition, organic matter is oxidized and inorganic matter remains. (A.O.A.C 1970).

Total ash (%) = $\frac{w_3 - w_2}{w_1}$ x100

Weight of sample = W_1
Weight of silica crucible = W_2
Weight of silica crucible + ash = W_3
Weight of silica Ash = W_3- W_2

Total digestible nutrient (TDN): Total digestible nutrients were calculated on the basis of value of crude protein, ether extract, crude fibre, and nitrogen free extract for each treatment. These values were converted to digestible values by multiplying with their respective conversion factor (Sen and Ray, 1964). Conversion factor for bajra for digestibility of crude protein, ether extract, crude fiber and nitrogen free extract were 0.62, 0.67, 0.60 and 0.69, respectively. Having determined the digestibility for various components, the TDN was calculated as under:

TDN (%) = Digestible crude protein (%) + Digestible crude fibre (%) + Digestible NFE (%) + [Digestible crude fat (%) x 2.25*]

*Digestible fat was multiplied by 2.25 as fat contains 2.25 times more energy than carbohydrate and protein.

Nitrogen free extract: Nitrogen free extract (NFE) was calculated by adding together the percentage of crude protein, crude fat, crude fiber and mineral matter and then subtracting from 100 as described by Knowles and Watkins (1960).

NFE (%) = 100 — (CP % + CF% + EE% + Total ash %)

Where: CP = Crude protein, CF = Crude fiber, EE= Ether extract
Where: CP = Crude protein, CF = Crude fiber, EE= Ether extract

Nutrient concentration and uptake: Nitrogen content: Nitrogen content in Pearl millet fodder was estimated by modified kjeldahl's method (Snell and Snell, 1949).

Zinc content: Zinc content in fodder was estimated by atomic absorption spectrophotometer (Lindsay and Norwell, 1978).

Nutrient uptake: The uptake of nitrogen and zinc in each plot by the crop was computed by using the following formula.

$$N \text{ uptake } (kg\ ha^{-1}) = \frac{\text{Nitrogen } (\%) \times \text{Dry matter yield } (kg\ ha^{-1})}{100}$$

$$Zn \text{ uptake } (gm\ ha^{-1}) = \frac{\text{Zinc content (ppm)} \times \text{Dry matter yield } (kg\ ha^{-1})}{1000}$$

Economics of treatments: The economics of different treatments was worked out in terms of net returns (₹ ha^{-1}) and B: C ratio, on the basis of prevailing market price for input and outputs.

Net returns: The cost of cultivation for each treatment was subtracted from the gross returns worked out for the respective treatment to arrive at net returns for each treatment.

Benefit: Cost ratio: Treatment wise benefit: cost ratio was calculated to ascertain economic viability of the treatment using the following formula:

$$B{:}C \text{ ratio} = \frac{\text{Gross returns } (₹\ ha^{-1})}{\text{Cost of cultivation } (₹\ ha^{-1})}$$

Statistical analysis: Analysis of variance and test of significance: The experimental data recorded for growth, yield, nutrients and quality characters were subjected to statistical analysis in accordance with the "Analysis of variance" technique suggested by Fisher (1950) for Randomized Block design. The critical difference (CD) for the treatment comparisons were worked out wherever the variance ratio (F test) was found significant at 5 per cent level of probability. To elucidate the nature and magnitude of treatment effects, summary Tables along with SEm. ± and CD (P=0.05) were prepared and given in chapter entitled "Experimental Results" and their analysis of variance for different parameters are given in the "Appendices".

RESULTS

An experiment entitled "Performance of Nitrogen and Zinc levels on growth, yield, quality and economics of fodder Pearl millet under Dry land condition" was conducted at the Agriculture farm of Bhagwant University Ajmer during 2015-16.

An investigation was carried out to evaluate the effect of different levels of nitrogen and zinc in terms of growth, quality and yield performance of pearl millet FBC16 and to find out the economic feasibility of the treatments. The experiment was laid out in Factorial Randomized Block Design, replicated thrice with twenty treatments, which comprised of Nitrogen and Zinc levels. During the course of field experimentation, the observations recorded on plant growth, yield attributes, yield and quality of cotton as influenced by various intercrops were presented and are discussed in this chapter supported with probable, logical reasoning and appropriate evidence.

Growth characters:-Plant population

Nitrogen level: It is explicit from the data (Table 7) that different dose of nitrogen had non-significant effect on plant population per meter row length recorded at 25 and 90 DAS. Mean value of data indicated that the maximum number of plants (15.25 and 12.61) per meter row length was recorded with 130 N kg ha^{-1} at 25 and 90 DAS, respectively, While the minimum number of plants (14.71 and 12.21) per meter row length was recorded with no nitrogen control treatment at both the stages.

Zinc level: It is evident from the data (Table 7) that different Zn levels had non-significant affect on plant population at 25 and 90 DAS. However the maximum plant population (14.95) per meter row length was recorded with control and 25 kg $ZnSO_4$ ha^{-1} at 25 DAS and minimum plant population (14.94) per meter row length was noted with the same Zn level at 90 DAS also.

Plant height: Nitrogen level:-First cutting: It is explicit from the data (Table 7) that plant height was significantly increased with increasing dose of nitrogen from 0 to 130 kg N ha^{-1}. Application of nitrogen @ 130 kg N ha^{-1} significantly recorded maximum height at 45 and 90 DAS (190.93 & 101.06 cm 1st and 2nd cutting) than the rest of treatment. Treatment N_0 Control observed minimum plant height (120.45 & 62.95 cm) among all the treatments.

Zinc level:-First cutting: It is explicit from the data (Table 7) that plant height of fodder pearl millet increased with zinc sulphate application up to 50 kg ha^{-1}. The application of 50 kg $ZnSO_4$ ha^{-1} significantly recorded higher plant height (162.15 cm) than rest of treatments at the time of 1st cutting. Treatment N_{50} being at par over all treatments.

Table 7. Effect of nitrogen and zinc levels on plant population and plant height and number of Leaves per plant of fodder pearl millet

Treatments	Plant Population		Plant Height (cm)	
	25 DAS	90 DAS	1st cutting (45 DAS)	2nd cutting (90 DAS)
Nitrogen levels (kg ha^{-1})				
N_0	14.71	12.21	120.45	62.95
N_{45}	14.88	12.33	133.14	78.35
N_{65}	14.92	12.38	160.78	87.38
N_{105}	15.10	12.54	185.41	96.43
N_{130}	15.25	12.61	190.93	101.06
S.Em ±	0.43	0.32	3.67	1.86
CD at 5%	NS	NS	6.66	5.32
$ZnSO_4$ levels (kg ha^{-1})				
Zn_0	14.95	13.40	145.72	77.38
Zn_{20}	1490	13.25	152.11	78.21
Zn_{25}	14.94	13.39	158.26	82.66
Zn_{45}	14.90	13.29	162.15	84.05
S.Em ±	0.30	0.29	2.45	1.88
CD at 5%	NS	NS	6.88	4.69

Second cutting: It is evident from the data presented in Table 7 that highest plant height (87.05 cm) was recorded with the application of 50 kg $ZnSO_4$ ha^{-1}, although it was statistically at par with 20, 30 kg $ZnSO_4$ ha^{-1} dose. Application of 25 kg $ZnSO_4$ ha^{-1} being at par with 20 kg $ZnSO_4$ dose recorded significant higher plant height by (82.66 cm) over control.

Number of Tillers per plant:-Nitrogen level

First cutting: It is explicit from data (Table 8) that application of nitrogen @ 130 kg N ha^{-1} significantly increased number of tillers plant^{-1} by 5.20 than the rest of treatments and being par over all treatments. Treatment N_{105} was in the second position.

Second cutting: It is explicit from data (Table 8) that application of nitrogen @ 130 kg N ha^{-1} significantly increased number of tillers plant^{-1} by 4.10 than the rest of treatments and being par over all treatments. Treatment N_{105} was in the second position. Control plot recorded minimum number of tillers per plant.

Zinc level:-First cutting: It is explicit from the data (Table 8) that increasing dose of zinc sulphate from 0 to 50 kg $ZnSO_4$ ha^{-1} significantly increased tillers per plant at 50 DAS. The maximum tiller per plant (5.40) was recorded with $ZnSO_4$ dose @ 50 kg ha^{-1} which was found at par to 25 kg $ZnSO_4$ ha^{-1} dose. Application of 25kg $ZnSO_4$ ha^{-1} recorded significantly higher number of tillers per plant by 3 per cent higher over control than at the first cutting stage.

Second cutting: Data presented in Table 8 revealed that application of $ZnSO_4$ @ 25kg ha^{-1} significantly increased number of tillers per plant 3.75 over control and 20 kg $ZnSO_4$ ha^{-1}, respectively. Further, $ZnSO_4$ application @ 50 kg ha^{-1} was found to be at par with25 kg ha^{-1} dose

Number of leaves per plant: Nitrogen level:-First cutting: Data given in Table 8 showed that increasing dose of nitrogen from 0 to 130 kg N ha^{-1} significantly increased number of leaves per plant. The maximum number of leaves per plant (15.44) was recorded with $ZnSO_4$ dose @ 130 kg ha^{-1} which was found at par to 65 kg Nitrogen ha^{-1} dose.

Zinc level:-First cutting: Data presented in Table 8 showed that application of $ZnSO_4$ by 25 kg ha^{-1} significantly increased number of leaves per plant by 12.58 over control 20 kg $ZnSO_4$ ha^{-1}. However, $ZnSO_4$ application @50 kg ha^{-1} was found to be at par with 25 and 20 kg ha$^{-1.}$

Second cutting: It is evident from the data in Table 4.1.2 that increasing $ZnSO_4$ dose from 0 to 50 kg ha^{-1} significantly increased number of leaves per plant. Application of $ZnSO_4$ @ 50 kg ha^{-1}recorded the highest number of leaves plant^{-1} (7.88) which was significantly higher than control. 20 and 25 kg $ZnSO_4$ ha^{-1}, respectively.

Leaf: stem ratio:-Nitrogen level:-First cutting: It is explicit from the data in Table 9 that increasing dose of nitrogen from 0 to 105 kg N ha^{-1} significantly enhanced the leaf: stem ratio (LSR) of fodder pearl millet of first cutting stage (45 DAS). Application of 90 kg N ha^{-1} significantly increased LSR by 67.21, 29.20 and 14.97 per cent over control and 45, 65 kg N ha^{-1} at the first cutting stage. However nitrogen application @ 130 kg ha^{-1} was found to be at par with higher N dose (105 kg N ha^{-1}) in respect to LSR at the time first cutting stage (45 DAS).

Second cutting: Data presented in Table 9 showed that increasing dose of nitrogen from 0 to 90 kg N ha^{-1} significantly enhanced the LSR of fodder pearl millet of first cutting stage (45 DAS). Application of @ 105kg N ha^{-1} significantly increased LSR by 76.08, 31.71 and 14.37 per cent over control, 45 and 65 kg N ha^{-1}, respectively. However nitrogen application 130 kg N ha^{-1} was found to be at par with higher N level (105 kg N ha^{-1}).

Zinc level:-First cutting: It is explicit from the data in Table 9 that application of $ZnSO_4$ @ 45 kg ha^{-1} significantly increased LSR of pearl millet plant by 24.82 and 12.68 per cent over control and 20 kg $ZnSO_4$ ha^{-1}, respectively at the first cutting stage. However, $ZnSO_4$ application @ 50 kg ha^{-1} was found to be at par with 20 kg ha^{-1} in this regard of first cutting stage.

Second cutting: It is evident from the data presented in Table 9 that application of $ZnSO_4$ @ 50kg ha^{-1} significantly increased

Table 8. Effect of nitrogen and zinc levels on tillers per plant and number of leaves per plant of fodder pearl millet

Treatments	Number of tillers plant^{-1}		Number of leaves plant^{-1}	
	1st cutting	2nd cutting	1st cutting	2nd cutting
Nitrogen levels (kg ha^{-1})				
N_0	3.96	2.54	9.98	4.07
N_{45}	4.35	2.82	10.75	6.25
N_{65}	4.55	2.93	12.88	7.12
N_{105}	4.90	3.25	14.35	8.89
N_{130}	5.20	4.10	15.44	9.23
S. Em ±	0.09	0.05	0.20	0.09
CD at 5%	0.13	0.10	0.60	0.25
$ZnSO_4$ levels (kg ha^{-1})				
Zn_0	5.09	3.60	11.59	6.25
Zn_{20}	5.30	3.55	11.89	6.35
Zn_{25}	5.36	3.65	12.58	6.80
Zn_{50}	5.40	3.75	12.67	7.88
S. Em ±	0.07	0.05	0.20	0.09
CD at 5%	0.12	0.09	0.44	0.54

Second cutting: Data presented in Table 8 indicated that increasing level of nitrogen from 0 to 130 kg N ha^{-1} significantly increased number of leaves per plant by 9.23, 8.09, 7.12, 6.25 and 4.07 higher over control, 45, 65 and 105 kg N ha^{-1}, respectively at second cutting stage (90 DAS).

LSR per plant by 28.46 and 14.99 per cent over control and 20 kg $ZnSO_4$ ha^{-1} respectively. However, $ZnSO_4$ application @ 25 kg ha^{-1} was found to be at par with 45 kg ha^{-1} in this regard of second cutting stage.

Table 9. Effect of nitrogen and zinc levels on leaf: stem ratio of fodder pearl millet

Treatments	Leaf : stem ratio	
	1st cutting	2nd cutting
Nitrogen levels (kg ha^{-1})		
N_0	0.28	0.20
N_{45}	0.29	0.23
N_{65}	0.38	0.25
N_{105}	0.40	0.29
N_{130}	0.44	0.31
S. Em ±	0.01	0.01
CD at 5%	0.03	0.03
$ZnSO_4$ levels (kg ha^{-1})		
Zn_0	0.28	0.19
Zn_{20}	0.31	0.22
Zn_{25}	0.37	0.26
Zn_{50}	0.45	0.28
S. Em ±	0.02	0.02
CD at 5%	0.03	0.04

Chlorophyll content: Nitrogen level: First cutting: It is explicit from the data in Table 10 showed that increasing dose of nitrogen from 0 to 130 kg N ha^{-1} significantly increased chlorophyll 'a' of leaves further data in Table in Table 10 show that application of nitrogen @ 105 kg N ha^{-1} significantly increased chlorophyll 'b'. As well as total chlorophyll content of fodder Pearl millet leaves increased with increasing dose of nitrogen from 0 to 130 kg N ha^{-1}.

Second cutting: It is explicit from the data in (Table 10) showed that nitrogen application @ 105 kg N ha^{-1}significantly increased chlorophyll 'a' of leaves by 24.53, 11.86 and 6.45 per cent over control, 45 and 65 kg N ha^{-1} respectively. However nitrogen application @ 130 kg ha^{-1} was found to be at par with higher N dose of 105 kg N ha^{-1}.Further data in (Table 10) revealed that nitrogen application @ 105 kg N ha^{-1}significantly increased chlorophyll 'b' by 24.71, 12.39 and 6.02 per cent over control, 25 and 65 kg N ha^{-1} respectively. However nitrogen application @ 130 kg ha^{-1} was found to be at par with higher N dose of 105 kg N ha^{-1}.

Zinc level: First cutting: It is explicit from the data in (Table 10) showed that application of 50 kg $ZnSO_4$ ha^{-1} significantly recorded highest chlorophyll 'a' content (1.41 mg g^{-1}) over control (1.28 mg g^{-1}) and 20 kg $ZnSO_4$ ha^{-1} (1.32 mg g^{-1}). Further data in [Table 10)] indicated that application of 50 kg $ZnSO_4$ ha^{-1} was significantly recorded higher chlorophyll 'b' content (0.94 mg g^{-1}) of leaves compared preceding dose of $ZnSO_4$ dose and control (0.92 mg g^{-1}) at the first cutting stage.

Second cutting: Data given in (Table 10) showed that application of 50 kg $ZnSO_4$ ha^{-1} was significantly recorded higher chlorophyll 'a' content (1.29 mg g^{-1}) as compared to minimum value under control (1.14 mg g^{-1}) further data in Table 10 indicated that application of 50 kg $ZnSO_4$ ha^{-1} recorded higher chlorophyll 'b' content (0.86 mg g^{-1}) as compared to control (0.74 mg g^{-1})**.** Data presented in Table 10.

Fodder yield: Green fodder yield: Nitrogen levels: First cutting: A critical examination of data in (Table 11) clearly showed that increasing dose of nitrogen from 0 to 130 kg N ha^{-1} significantly enhanced green fodder yield (GFY) of fodder pearl millet at 45 DAS. Application of 130 kg N ha^{-1} significantly recorded highest green fodder yield (200.54) than rest of the treatments therefore application 105130 kg N ha^{-}1 has second position in terms of green fodder yield.

Table 10. Effect of nitrogen and zinc levels on Chlorophyll content of fodder pearl millet

Treatment	Chlorophyll content of leaves (mg g^{-1})					
	1st cutting			2nd cutting		
	Chl 'a'	Chl 'b'	Total	Chl 'a'	Chl 'b'	Total
Nitrogen levels (Kg ha^{-1})						
N_0	1.25	0.85	2.1 0	1.11	0.75	1.86
N_{45}	1.31	0.90	2.21	1.20	0.82	2.02
N_{65}	1.42	0.97	2.49	1.35	088	2.23
N_{105}	1.49	0.98	2.47	1.42	0.91	2.33
N_{130}	1.59	1.00	2.59	1.54	0.98	2.52
S.Em ±	0.02	0.01	0.03	0.02	0.01	0.03
CD at 5%	0.04	0.04	0.06	0.06	0.05	0.11
$ZnSO_4$ levels (Kg ha^{-1})						
Zn_0	1.25	0.83	2.08	1.14	0.76	1.91
Zn_{15}	1.32	0.88	2.19	1.21	0.81	2.02
Zn_{30}	1.39	0.92	2.31	1.28	0.85	2.13
Zn_{45}	1.41	0.94	2.36	1.29	0.86	2.15
S.Em ±	0.02	0.01	0.03	0.02	0.01	0.03
CD at 5%	0.05	0.03	0.08	0.05	0.04	0.09

Second cutting: Data presented in (Table 11) revealed that increasing nitrogen levels from 0 to 130 kg N ha^{-1} significantly enhanced GFY of pearl millet at second cutting stage. Application of 130 kg N ha^{-1} being at par over all treatments).

Total green fodder yield: Data given in (Table 11) revealed that increasing dose of nitrogen from 0 to 130 kg ha^{-1} significantly improved total GFY of fodder pearl millet. Application of nitrogen @ 130 kg ha^{-1} significantly observed highest total green fodder yield.

Zinc level:-First cutting: It is explicit from the data in (Table 11) that application of 30 kg $ZnSO_4$ ha^{-1} significantly increased GFY by 19.61 and 7.62 per cent over control and 15 kg $ZnSO_4$ ha^{-1} though it was found at par with 45 kg $ZnSO_4$ ha^{-1} at the first cutting stage (45 DAS).

Second cutting: It is evident from the (Table 11) that application of 30 kg $ZnSO_4$ ha^{-1} significantly increased GFY by 15.27 and 7.62 per cent over control and 15 kg $ZnSO_4$ ha^{-1} and was found to be at par with 45 kg $ZnSO_4$ ha^{-1} at the second cutting stage (90 DAS).

Table 11. Effect of nitrogen and zinc levels on green fodder yield of fodder pearl millet

Treatment	Green fodder yield (q ha^{-1})		
	1st cutting	2nd cutting	Total
Nitrogen levels (kg ha^{-1})			
N_0	154.46	119.99	273.45
N_{45}	179.89	144.08	323.97
N_{65}	184.59	156.98	340.57
N_{105}	195.89	178.72	373.61
N_{130}	200.54	184.21	384.75
S.Em ±	2.48	4.45	5.96
CD at 5%	6.48	7.48	13.05
$ZnSO_4$ levels (kg ha^{-1})			
Zn_0	165.59	149.42	315.01
Zn_{20}	176.65	158.35	335.00
Zn_{25}	184.63	166.78	351.31
Zn_{50}	185.43	167.25	352.68
S.Em ±	2.28	3.43	5.71
CD at 5%	6.52	9.81	16.33
CV (%)	5.13	8.46	13.59

Dry matter yield:-Nitrogen levels:- First cutting: It is inferred from data in (Table 12) that nitrogen application @ 130 kg N ha^{-1} significantly recorded maximum dry matter yield (38.50) than other treatments. Nitrogen application @

130 kg N ha^{-1} at par on other treatments. Control N_0 observed lowest dry matter yield at first cutting.

Second cutting: It is evident from the data presented in (Table 12) that nitrogen application @ 130 kg N ha^{-1} significantly increased DMY (35.25) than application of 105, 65 and 45 kg N ha^{-1}

Total Dry matter yield: Data given in (Table 12) opined that increasing dose of nitrogen from 0 to 130 kg N ha^{-1} significantly improved total DMY fodder of pearl millet. Application of Nitrogen @105 kg N ha^{-1} significantly increased DMY by 70.77, 42.27 and 21.03 per cent over control, 30, and 60 kg N ha^{-1} but was found at par with 130 kg N ha^{-1}.

Zinc level: First cutting: It is clear from the data in (Table 12) that the application of 30 kg $ZnSO_4$ ha^{-1} significantly improved DMY by 29.82 and 14.98 per cent over control and 15 kg $ZnSO_4$ ha^{-1} but was found at par with 45 kg $ZnSO_4$ ha^{-1}.

Second cutting: It is evident from the data presented in (Table 12) that the application of 50 kg $ZnSO_4$ ha^{-1} obtained highest total dry matter yield (27.29) than the rest of treatments.

Total Dry matter yield: highest total dry matte significantly recorded by the application of $ZnSO_4$ @ 50 kg ha^{-1} (59.16). Application of $ZnSO_4$ @ 25 kg ha^{-1} (55.32$^)$ obtained second position just after application of $ZnSO_4$ @ 50 kg ha^{-1}

Table 12. Effect of nitrogen and zinc levels on dry matter yield of fodder pearl millet

Treatment	Dry matter yield (q ha^{-1})		
	1^{st} cutting	2^{nd} cutting	Total
Nitrogen levels (kg ha^{-1})			
N_0	22.29	19.67	41.86
N_{45}	25.90	24.68	50.58
N_{65}	29.86	26.85	55.71
N_{105}	32.85	30.35	63.20
N_{130}	38.55	35.25	73.80
S.Em ±	2.11	1.25	2.18
CD at 5%	5.22	2.75	5.54
$ZnSO_4$ levels (kg ha^{-1})			
Zn_0	24.17	20.56	44.73
Zn_{20}	28.25	24.46	52.71
Zn_{25}	31.08	26.24	55.32
Zn_{50}	32.87	27.29	59.16
S.Em ±	0.98	0.60	1.08
CD at 5%	2.80	1.90	3.09

Quality parameter: Crude protein content: Nitrogen levels: First cutting: Data in (Table 13) showed that increasing dose of up to130 kg ha^{-1} nitrogen levels improved crude protein content of fodder pearl millet analyzed at first cutting stage. Nitrogen level of 130 kg N ha^{-1} noted the highest crude protein content (10.25%) at the time of first cutting. which was statistically proved to at par with 105 kg N ha^{-1} dose but significantly superior over 45, 105 kg N ha^{-1}.

Second cutting: Data presented in (Table 13) revealed that nitrogen levels had significant effect on crude protein content in fodder pearl millet at second cutting also. Application of 130 kg N ha^{-1} being at par to 105 kg ha^{-1}.recorded significantly higher crude protein content (9.75%) as compared to lower levels and control.

Zinc levels:-First cutting: An examination of data in (Table 13) revealed that increasing $ZnSO_4$ dose from 0 to 50kg ha^{-1} improved crude protein content of fodder pearl millet. The maximum CP (9.45) was noted with the highest level of $ZnSO_4$ (50 kg ha^{-1}) which was significantly superior over control and also application of 20kg $ZnSO_4$ dose proved statistically superior over control.

Second cutting: Data (Table 13) revealed that $ZnSO_4$ dose of 50 kg ha^{-1} had significant effect on crude protein content in comparison to control and lower doses.

Crude fiber:-Nitrogen levels:-First cutting: The data presented in (Table 13) indicated that application of nitrogen levels had no significant effect on the crude fiber content in fodder pearl millet at first cutting stage (45 DAS). Though the maximum crude fiber content (31.56%) was recorded under 130kg N ha^{-1} which was higher than application of 105, 65 and 45 N kg $^{hac-1}$.

Second cutting: Data presented in (Table 13) revealed that almost similar trend in crude fiber content was also observed with varying dose of nitrogen application. Application 130 kg N ha^{-1} recorded higher crude fiber content (31.11%) as compared to 65, 45kg N ha^{-1} and control.

Zinc levels: First cutting: Data presented in (Table 13) indicated that application of Zinc sulphate levels had no significant effect on the crude fiber content in fodder pearl millet. The maximum crude fiber content (30.97 %) was recorded less than 50 kg $ZnSO_4$ ha^{-1} as against the minimum crude fiber under control (28.05%) at the first cutting stage.

Second cutting: A perusal of data in (Table 13) revealed that zinc sulphate doses had no significant effect on crude fiber content in fodder pearl millet at second cutting. Though application of increasing dose of $ZnSO_4$ ha^{-1} gave higher crude fiber content in comparison to control but statistically proved non significant.

Table13. Effect of nitrogen and zinc levels on crude protein and crude fiber of fodder pearl millet

Treatment	Crude protein (%)		Crude fiber (%)	
	1^{st} cutting	2^{nd} cutting	1^{st} cutting	2^{nd} cutting
Nitrogen levels (Kg ha^{-1})				
N_0	7.85	7.11	28.78	28.62
N_{30}	8.98	7.36	29.23	28.78
N_{60}	9.55	8.11	29.78	29.52
N_{90}	10.07	9.52	31.20	31.09
N_{120}	10.25	9.75	31.56	31.11
S.Em ±	0.21	0.12	0.75	0.56
CD at 5%	0.63	0.36	NS	NS
$ZnSO_4$ levels (Kg ha^{-1})				
Zn_0	8.00	7.45	28.05	29.34
Zn_{20}	8.05	7.90	29.38	29.52
Zn_{25}	8.79	8.20	29.45	30.52
Zn_{50}	9.45	9.35	30.97	30.78
S.Em ±	0.16	0.14	0.97	0.91
CD at 5%	0.48	0.56	NS	NS

Ether extract: Nitrogen levels: First cutting: An examination of data presented in (Table 14) when compared with control clearly revealed that application of nitrogen @ 65 kg N ha^{-1} had a significantly improved crude fat content in fodder pearl millet at first cutting. Whereas, crude fat content was not affected with further increase in N level up to130 kg ha^{-1}.

Second cutting: It was found that crude fat content was not influenced significantly due to increasing N level from 0 to 130 kg N ha^{-1} (Table 14).

Zinc levels: First cutting: The data presented in Table 14 show that increasing dose of $ZnSO_4$ from 0 to 50 kg ha^{-1} did not affect crude fat content in fodder pearl millet at first cutting stage

Second cutting: Data in Table 14 showed that increasing dose of $ZnSO_4$ from 0 to 50 kg $ZnSO_4$ ha^{-1} had no significant effect on crude fat content in fodder pearl millet at second cutting.

Ash:-Nitrogen levels: First cutting: The data presented in Table 14 indicated that application of varying nitrogen dose had no significant effect on ash content in fodder pearl millet, during first cutting stage.

Second cutting: Data in Table 14 clearly show that varying dose of nitrogen from 0 to 130 kg N ha^{-1} had no significant effect on mineral matter content in fodder pearl millet, through increasing trend was observed with N doses.

Zinc levels:- First cutting: The data presented in (Table 15) indicated that increasing dose of $ZnSO_4$ had no significant effect on the mineral matter content in fodder pearl millet at 45 DAS, though the maximum mineral matter content (12.60%) was recorded with the highest dose of $ZnSO_4$ ha^{-1} (45 kg ha^{-1}).

Second cutting: A perusal of data presented in (Table 15) showed that increasing dose of $ZnSO_4$ did not influence the mineral matter content in fodder pearl millet at 90 DAS. The maximum mineral matter content (11.90 %) was recorded less than 50 kg Zn SO_4 ha^{-1} as against the minimum value 11.37 per cent over control treatment.

Table 14. Effect of nitrogen and zinc levels on ether extract and ash of fodder pearl millet

Treatment	Ether extract (%)		Ash (%)	
	1st cutting	2nd cutting	1st cutting	2nd cutting
Nitrogen levels (Kg ha^{-1})				
N_0	2.56	2.09	11.22	10.26
N_{45}	2.75	2.53	11.98	10.98
N_{65}	2.98	2.78	12.35	11.61
N_{105}	3.21	2.86	12.56	11.80
N_{130}	3.45	2.96	12.66	11.95
S.Em ±	0.06	0.08	0.35	0.37
CD at 5%	0.18	0.24	NS	NS
$ZnSO_4$ levels (Kg ha^{-1})				
Zn_0	4.28	3.00	12.16	11.37
Zn_{15}	4.76	3.04	12.26	11.49
Zn_{30}	4.90	3.20	12.45	11.68
Zn_{45}	5.50	3.50	12.60	11.90
S.Em ±	0.11	0.13	0.32	0.33
CD at 5%	NS	NS	NS	NS

Nitrogen free extract: Nitrogen levels: First cutting: A critical examination of data presented in (Table 15)showed that increasing level of nitrogen up to 30 kg N ha^{-1} had no significant on nitrogen free extract content in fodder pearl millet at the first cutting stage. Further, increase in N dose to 130 kg ha^{-1} resulted in significant increase nitrogen free extract. However application of 130 kg hac^{-1} was found at par with 65 and 45 kg N ha^{-1} dose.

Second cutting: It is evident from the data presented in (Table 15) that nitrogen levels up to 45 kg ha^{-1} had no significant effect on nitrogen free extract content in fodder pearl millet at second cutting stage. The maximum nitrogen free extract was recorded in no nitrogen application (55. 23%) treatment which decreased gradually with increase in N levels up to 130 kg ha^{-1}. The minimum nitrogen free extract (48.49%) was noted under 130 kg ha^{-1} which was significantly less compared to 45 kg N ha^{-1} and control.

Zinc levels: First cutting: A perusal of data presented in (Table 15) showed that the highest nitrogen free extract was observed under no zinc control (50.78) which decreased gradually by increase in application of $ZnSO_4$ doses and significantly by 45 kg $ZnSO_4$ dose.

Second cutting: It is evident from the data presented in (Table 15) that application of 50 kg $ZnSO_4$ ha^{-1} significant increased nitrogen free extract compared to control in fodder pearl millet at second cutting (90 DAS).

Total digestible nutrient: Nitrogen levels: First cutting: The data presented in (Table 15) revealed that application of nitrogen up to 65 kg ha^{-1} had no significant effect on the total digestible nutrient content in fodder pearl millet at the first cutting stage. However, further increase in N dose up to 130 significantly reduced.

Second cutting: It was found that application of nitrogen in fodder pearl millet showed at most similar result of total digestible nutrient at 90 DAS which was obtained at the first cutting stage (Table 15).

Zinc levels:-First cutting: A perusal of data presented in (Table 16) showed that maximum TDN (60.08 %) was recorded under control and decreased gradually by adding $ZnSO_4$ dose up to 45 kg $ZnSO_4$ which was significantly less by 7.67 per cent compared to control.

Second cutting: It is evident from the data presented in (Table 16) that increasing dose of zinc sulphate up to 30 kg ha^{-1} did not influence total digestible nutrient content in fodder pearl millet at second cutting (90 DAS).

Table 15. Effect of nitrogen and zinc levels on nitrogen free extract and total digestible nutrient of fodder pearl millet

Treatment	Nitrogen free extract (%)		Total Digestible Nutrient (%)	
	1st cutting	2nd cutting	1st cutting	2nd cutting
Nitrogen levels (Kg ha^{-1})				
N_0	53.52	55.23	62.45	61.23
N_{45}	49.78	49.49	61.45	60.42
N_{65}	47.89	47.89	60.28	59.60
N_{105}	46.90	48.56	60.32	60.12
N_{130}	47.78	48.98	60.45	60.40
S. Em ±	0.61	0.72	0.33	0.56
CD at 5%	2.52	2.33	0.99	1.73
$ZnSO_4$ levels (Kg ha^{-1})				
Zn_0	50.78	51.45	61.92	62.51
Zn_{20}	50.12	51.22	60.80	62.35
Zn_{25}	49.89	50.23	60.60	62.12
Zn_{50}	49.55	48.80	60.43	61.85
S. Em ±	0.55	0.80	0.25	0.23
CD at 5%	1.05	1.40	0.80	NS

Nutrient content and uptake: Nitrogen content: First cutting: The data presented in (Table 16) indicates that increasing nitrogen levels up to 130 kg ha^{-1} significantly affect nitrogen content in fodder pearl millet at first cutting during experimental year. The maximum nitrogen content (2.00%) was recorded under 130 kg N ha^{-1} being at par with 105 kg N

ha^{-1} (1.98 %) and proved significantly superior over 45, 65 kg N ha^{-1} and control.

Second cutting: It was found in (Table 16) that application of 130 kg N ha^{-1} had significantly effect on the nitrogen content in fodder pearl millet at second cutting (Table 16) The highest nitrogen content (1.98%) was recorded under 130 kg N ha^{-1} being at par with 105 and 65 kg N ha^{-1}.

Zinc levels: First cutting: The data presented in (Table 16) indicates that application of $ZnSO_4$ had significant effect on the nitrogen content in fodder pearl millet at first cutting during experimental year. The maximum nitrogen content (2.45%) was recorded less than 50 kg $ZnSO_4$ ha^{-1} which was significantly higher by 15.41 per cent over control.

Second cutting: It was found in (Table 16) that application of 50 kg $ZnSO_4$ ha^{-1} had significantly affected on the nitrogen content in fodder pearl millet at second cutting. The highest nitrogen content (1.89%) was recorded less than 50 kg $ZnSO_4$ ha^{-1} which was significantly higher over control.

Nitrogen uptake: Nitrogen level: First cutting: The data presented in (Table 16) indicates that application of N 130 kg hac-1 had significant effect on the nitrogen uptake in fodder pearl millet at first cutting during experimental year. The maximum nitrogen uptake (26.22) was recorded under 130 kg N ha^{-1} which was significantly higher than rest of treatments.

Second cutting: The data revealed that in (Table 16) indicates that application of N 130 kg hac^{-1} had significant effect on the nitrogen uptake in fodder pearl millet at first cutting during experimental year. The maximum nitrogen uptake (22.25) was recorded under 130 kg N ha^{-1} which was significantly higher than rest of treatments.

Total N uptake: The data presented in (Table 16) and depicted in indicates that application of nitrogen had significant affect on the nitrogen uptake in fodder pearl millet at first cutting stage. The maximum nitrogen uptake (90.44 kg ha^{-1}) was recorded under 130 kg N ha^{-1} being at par with 90 kg ha^{-1} (97.09 kg ha^{-1}) and both these were significantly higher over lower N doses and control.

Zinc level: First cutting: It is explicit from the data in (Table 17) that $ZnSO_4$ application up to 25 kg $ZnSO_4$ ha^{-1} had significantly affect on the nitrogen uptake in fodder pearl millet.

Second cutting: It is clear from the data in (Table 17) showed that application of 25 kg $ZnSO_4$ ha^{-1} had significantly affect on the nitrogen uptake in fodder pearl millet. The maximum Zn uptake (38.27 kg ha^{-1}) was recorded less than 50 kg $ZnSO_4$ N $ha^{-1.}$

Total Zn uptake: It is inferred from data (Table 17) and depicted in application of $ZnSO_4$ from 0 to 50 kg ha^{-1} had significantly enhanced the Zn uptake in fodder pearl millet at both cutting. The highest Zn uptake (88.74 kg ha^{-1}) was recorded less than 50 kg ZnSO4 ha^{-1} which was higher than other treatments.

Zinc content: Nitrogen level: First cutting: The data presented in (Table 17) indicated that nitrogen application up to 105 kg ha^{-1} had not significantly effect on the Zn content in fodder pearl millet at first cutting stage. However, the maximum Zn content (37.43 PPM) was recorded less than 130 kg N ha^{-1} which showed statistically superiority than other treatments.

Table 16. Effect of nitrogen and zinc levels on nitrogen content and nitrogen uptake of fodder pearl millet

Treatment	Nitrogen content (%)		Nitrogen uptake (kg ha^{-1})		
	1^{st} cutting	2^{nd} cutting	1^{st} cutting	2^{nd} cutting	Total
Nitrogen levels (kg ha^{-1})					
N_0	1.25	1.02	26.22	22.25	48.74
N_{45}	1.35	1.55	39.26	25.23	67.39
N_{65}	1.56	1.78	45.59	32.45	81.38
N_{105}	1.98	1.88	49.64	40.23	93.73
N_{130}	2.00	1.98	50.55	42.56	97.09
S.Em ±	0.04	0.03	2.50	1.06	3.63
CD at 5%	0.12	0.10	7.50	3.23	7.32
$ZnSO_4$ levels (kg ha^{-1})					
Zn_0	2.29	1.29	31.23	25.23	60.04
Zn_{20}	2.30	1.59	35.22	29.69	68. 80
Zn_{25}	2.35	1.76	42.65	35.21	81.97
Zn_{50}	2.45	1.89	46.13	38.27	88.74
S.Em ±	0.03	0.04	1.53	0.97	2.53
CD at 5%	0.09	0.12	4.37	2.79	7.37

Second cutting: It was found that application of 130 kg N ha^{-1} had significant affect on the Zn content in fodder pearl millet compared to control at second cutting stage (Table 17)). The highest per cent of Zn content (33.95ppm) was recorded less than 130 kg N ha^{-1}.

Zinc levels: First cutting: The data presented (Table 17) revealed that $ZnSO_4$ application @ 25 kg ha^{-1} significantly improved Zn content in fodder pearl millet at first cutting stage. Through the maximum Zn content (36.05ppm) was recorded under 50 kg $ZnSO_4$ ha^{-1} as against the minimum Zn content (38.26ppm) under control treatment.

Second cutting: Data given in Table 4.4.2 revealed that application from 0 to 45 kg $ZnSO_4$ ha^{-1} had significant affect on the Zn content in fodder pearl millet at second cutting stage. The highest per cent of Zn content (33.53) was recorded under 45 $ZnSO_4$ ha^{-1} which was significantly higher over 15 and 30 kg $ZnSO_4$ ha^{-1}.

Zinc uptake: Nitrogen level:-First cutting: It is clear from the data in (Table 17) that application of nitrogen @ 90 kg ha^{-1} significantly increased Zn uptake in fodder pearl millet by 151.17, 69.34 and 36.80 per cent over control, 45 and 65 kg N ha^{-1} but was found to be at par with 120 kg N ha^{-1}.

Second cutting: It is evident from the data in (Table 17) reveal that application of nitrogen @ 130 kg ha^{-1} significantly increased Zn uptake in fodder pearl millet. The highest per cent of Zn content (35.85) was recorded under 50 $ZnSO_4$ $ha^{-1.}$

Zinc level:-First cutting: It is explicit from the data in (Table 17) that application of 50 kg $ZnSO_4$ ha^{-1} had significant affected on the Zn uptake in fodder pearl millet which was significantly higher by 79.88, 41.04 and 13.95 per cent over control, 20 and 25 kg $ZnSO_4$ ha^{-1}.

Second cutting: It is clear from the data in (Table 17) showed that application of 25 kg $ZnSO_4$ ha^{-1} had significant affected on the Zn uptake in fodder pearl millet.

Economic evaluation of treatments: Net returns: Nitrogen levels: In reference to data (Table 18) showed that nitrogen application up to 130 kg ha^{-1} significant affected net returns ha^{-1}.

Table 17. Effect of nitrogen and zinc levels on zinc content and zinc uptake of fodder pearl millet

Treatment	Zn content (ppm)		Zn Uptake (gm ha^{-1})		
	1st cutting	2nd cutting	1st cutting	2nd cutting	Total
Nitrogen levels (kg ha^{-1})					
N_0	33.89	30.56	87.26	78.59	165.85
N_{45}	34.67	31.87	129.56	90.35	219.91
N_{65}	35.45	32.94	156.56	96.23	252.79
N_{105}	35.93	32.98	175.15	102.53	277.68
N_{130}	37.43	33.95	184.55	112.25	296.80
S.Em ±	1.05	0.96	9.48	4.11	13.59
CD at 5%	2.89	2.75	28.23	12.75	40.98
$ZnSO_4$ levels (kg ha^{-1})					
Zn_0	31.56	30.25	100.46	76.46	176.92
Zn_{20}	35.89	32.53	128.59	90.85	219.44
Zn_{25}	37.56	33.75	165.59	100.25	265.84
Zn_{50}	38.26	35.85	173.56	109.63	283.19
S.Em ±	0.89	0.86	6.69	3.25	9.94
CD at 5%	2.68	2.46	19.16	09.51	28.67

Table 18. Effect of nitrogen and zinc levels on net return and B : C ratio of fodder pearl millet

Treatment	Net returns (₹ ha^{-1})	B :C ratio
Nitrogen levels (kg ha^{-1})		
N_0	37,206	2.63
N_{45}	44,258	3.47
N_{65}	55,546	3.45
N_{105}	57,526	3.79
N_{130}	61,440	4.23
S.Em ±	1,119	
CD at 5%	3,321	
$ZnSO_4$ levels (kg ha^{-1})		
Zn_0	43,451	3.51
Zn_{20}	48,123	3.84
Zn_{25}	51,785	3.21
Zn_{50}	50,635	3.43
S.Em ±	1,023	
CD at 5%	3,211	

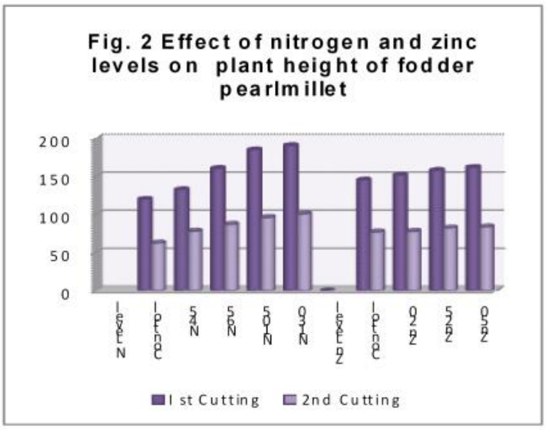


Fig. 2 Effect of nitrogen and zinc levels on plant height of fodder pearlmillet

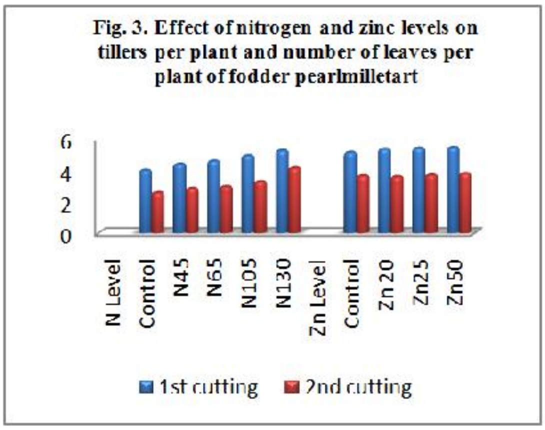


Fig. 3. Effect of nitrogen and zinc levels on tillers per plant and number of leaves per plant of fodder pearlmilletart

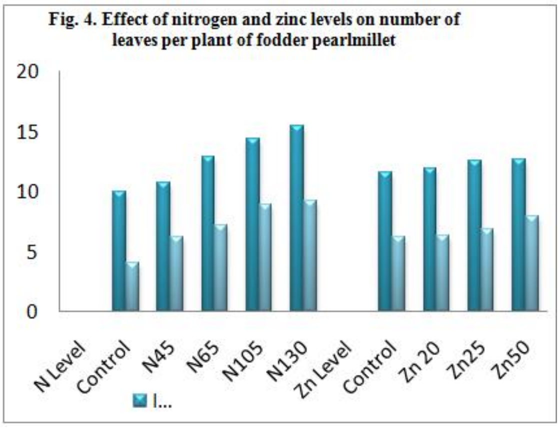


Fig. 4. Effect of nitrogen and zinc levels on number of leaves per plant of fodder pearlmillet

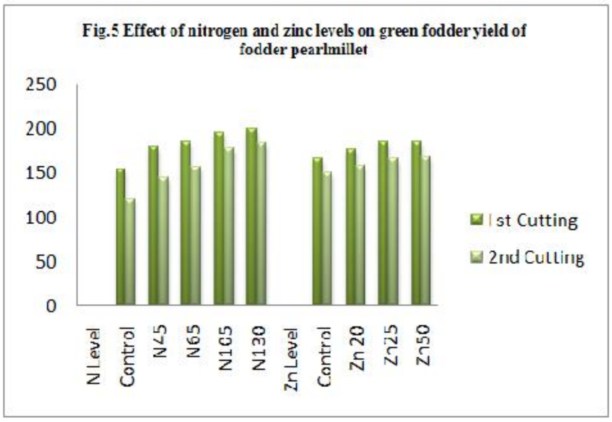
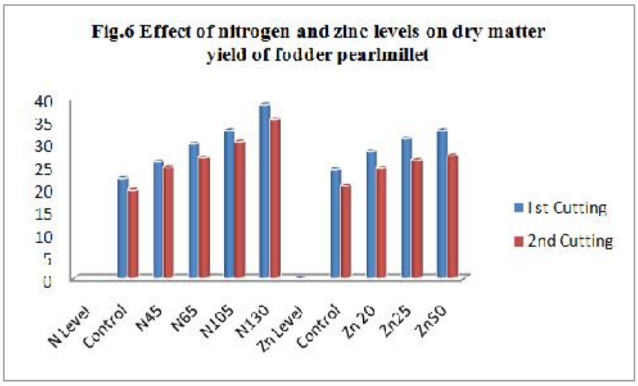
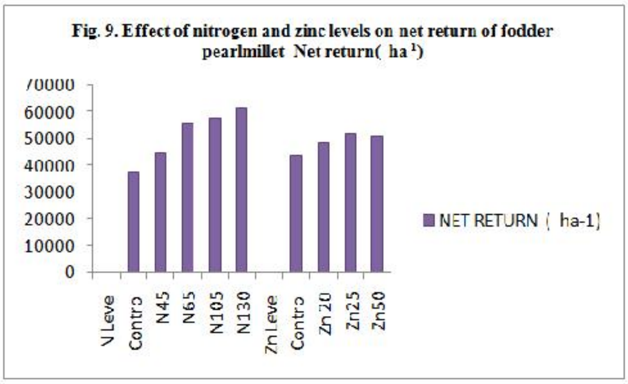


Fig.5 Effect of nitrogen and zinc levels on green fodder yield of fodder pearlmillet





The net returns increased with increasing application of nitrogen. The highest net returns of ₹61, 440 ha^{-1} were recorded with 130kg N ha^{-1}, which were significantly higher than the rest of the N doses. Control plot recorded lowest Net return among all treatments (37,206).

Zinc levels: In reference to data (Table 18) showed that $ZnSO_4$ had no significant effect on net returns ha^{-1}. The highest net returns of ₹51,785 ha^{-1} were recorded in 25 kg $ZnSO_4$ ha^{-1}, which were significantly higher than other Zn doses.

B: C ratio: Nitrogen levels:-It is explicit from the data in (Table 18) that nitrogen application shows significant effect on B: C ratio. The highest B:C ratio (4.23) was recorded with 130 kg N ha^{-1}, which was statistically at par with 105 kg N ha^{-1} (3.79) and both these were higher over control and lower N levels.

Zinc levels: It is explicit from the data in (Table 18) that $ZnSO_4$ application show no significant effect on B:C ratio. The highest B:C (3.69) was recorded in 20 kg $ZnSO_4$ ha^{-1}, which was higher over control (3.84).

Conclusion

The results of the field experiment entitled "Effect of nitrogen and zinc levels on growth, yield quality and economics of fodder pearl -millet (*Pennisetum americanum* L.)" conducted at Agriculture Farm, in Bhagwant University Ajmer during *Kharif* 2015 are presented in the proceeding chapter. The significant findings of investigation presented and discussed in preceding chapter are summarized as below:

Effect of Nitrogen dose on growth and yield of fodder pearl millet:

- There was not significant effect of increase in continuous dose of N fertilizer from 0 to 130 kg ha^{-1} on plant population at the time of first and second cutting stages (25 and 90 DAS).
- Application of nitrogen @ 130 kg ha^{-1} which was found statistically at par with the 105 kg N ha^{-1}, significantly increased plant height over control, 45 and 65 kg N ha^{-1} at both cutting stages.
- Application nitrogen @ 105 kg ha^{-1} which was found at par with 130 kg N ha^{-1} significantly increased number of tillers per plant over control, 45 and 65 kg N ha^{-1} at both cutting stages.
- As the increase application of nitrogen @ 130 kg ha^{-1} significantly increased number of leaves per plant over control and lower N levels at both cutting stage.
- Application nitrogen @ 90 kg ha^{-1} which was found at par with 120 kg N ha^{-1} significantly increased leaf: stem in fodder pearl millet over control, 30 and 60 kg N ha^{-1} at the both cutting stage.
- Application of nitrogen @ 130kg ha^{-1} significantly increased the total green fodder yield over all rest of the treatments.
- Application of nitrogen @ 130 kg N ha^{-1} significantly increased total dry matter yield.

Effect of Nitrogen on nutrient content, uptake quality and Economics:

- The maximum nitrogen content was recorded under 130 kg N ha^{-1} at the both cutting stage. Application of nitrogen @ 105kg ha^{-1} being at par to at par with 130 kg N ha^{-1} significantly increased N uptake in fodder pearl millet over control, 45 and 65 kg N ha^{-1}.
- Application of nitrogen @ 130 ha^{-1} noted the highest crude protein content in fodder pearl millet which was statistically at par with 105 kg N ha^{-1} dose and significantly superior over control, 45 and 65 kg N ha^{-1} at both cutting stage.
- Application of nitrogen had no significant affect on the crude fiber content in fodder pearl millet at both cutting stage. The maximum crude fiber content was noted under 130kg N ha^{-1}
- The maximum Ether extract was recorded less than 130 kg N ha^{-1} which was significantly higher over control at the first cutting stage. While at the time of second cutting stage, ether extract showed non-significant effect.
- Application of nitrogen @ 130 kg ha^{-1} resulted in significant decrease nitrogen free extract over 25 kg ha^{-1} and control, respectively, however it was found at par with 65 and 105 kg N ha^{-1} dose at the both cutting stage.
- The maximum Net return was recorded under Application of nitrogen @ 130 which was significantly higher over control at the first cutting stage. While at the time of second cutting stage, ether extract showed non-significant effect significantly due to increasing N level from 0 to 130 kg ha^{-1}.
- The fodder Pearl millet fertilized with 130 kg N130 ha^{-1} fetched significantly higher net return ₹61,440 ha^{-1} over control.

Effect of Zinc on growth and yield

- The fodder pearl millet crop fertilized with 0 to 50 kg $ZnSO_4$ ha^{-1} showed no significant variation in plant population at both cutting stage.

- The basal dose of 25 kg $ZnSO_4$ ha^{-1} significantly increased plant height of fodder pearl millet over control and 20kg $ZnSO_4$ ha^{-1} respectively but was found at par with 50 kg $ZnSO_4$ ha^{-1} dose at the both cutting stage.
- The application of 25 kg $ZnSO_4$ ha^{-1} significantly increased number of tillers per plant which was higher over control at the first cutting stage. While at the second cutting stage, application of $ZnSO_4$ @ 25kg ha^{-1} significantly increased number of tillers per plant over control and 20 kg $ZnSO_4$ ha^{-1} dose respectively.
- Application of $ZnSO_4$ @ 25 kg ha^{-1} significantly increased number of leaves per plant over control and 20 kg $ZnSO_4$ ha^{-1} at the first cutting stage. However, $ZnSO_4$ application @ 25 kg ha^{-1} was found to be at par with 50 kg ha^{-1}. While at the second cutting stage, application of $ZnSO_4$ @ 50 kg ha^{-1} recorded the higher number of leaves plant per plant in comparison to other application of Zn.
- Application of $ZnSO_4$ @ 25 kg ha^{-1} being at par with 50 kg ha^{-1} significantly increased leaf: stem ratio over control and 20 kg $ZnSO_4$ ha^{-1} at the both cutting stage.
- The application of 50 kg $ZnSO_4$ ha^{-1} significantly increased total green fodder yield
- The application of 50 kg $ZnSO_4$ ha^{-1} was significantly increased total dry matter yield over control and 20 kg $ZnSO_4$ ha^{-1} at the both cutting stage.

Effect of Zinc on nutrient content, uptake, quality and Economics

- Application of 50 kg $ZnSO_4$ ha^{-1} had significant effect on Zn content in fodder pearl millet at first cutting stage. While at the second cutting stage, application of 50kg $ZnSO_4$ ha^{-1} had significant effect over control and 20 kg $ZnSO_4$ ha^{-1}.
- The maximum Crude Protein was noted with 50 kg $ZnSO_4$ ha^{-1} which was significantly superior over lower doses of $ZnSO_4$ and control at both cutting stages.
- No zinc (control) recorded significantly higher nitrogen free extract content compared to 50 kg $ZnSO_4$ ha^{-1} at the both cutting stages.
- No zinc (control) recorded significantly higher total digestible nutrient (TDN) in fodder pearl millet compared to 50 kg $ZnSO_4$ ha^{-1} at the first cutting stage.
- The fodder Pearl millet fertilized with 25 kg $ZnSO_4$ ha^{-1} fetched significantly higher net return ₹ 51,785 ha^{-1} over control.
- During the entire research programme it was found that all the phonological parameters like plant height, number of functional leaves, total dry matter accumulation and leaf area were increased with increased the dose of both source of nutrients, in fact application of N130 and Zn 50 kg ha^{-1} were recorded higher phonological observation than the rest of treatments.
- Based on results of one year experimentation, it is concluded that in fodder pearl millet (variety FBC-16) fertilized with 130 kg N ha^{-1} recorded significantly higher total green fodder yield (384.75 q ha^{-1}) and total dry matter yield (73.80 q ha^{-1}) compared to other treatments
- It is concluded that and highest net return was obtained (61,440ha^{-1}) (51785) by with the application of N130 and Zn 25 Kg ha-1 respectively. Application of 25 kg $ZnSO_4$ ha^{-}1 and N130 N application recorded the highest B: C ratio () () respectively.
- Total Green fodder yield (384.75q ha^{-1}) and total dry matter yield (73.80 q ha^{-1}) which were significantly superior over control (273.45 q ha^{-1} GFY, 41.86 q ha^{-1} DFY$^{)}$.

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