RESPONSE OF FODDER MAIZE AND COWPEA MIXED CROPPING TO FYM, SEED RATE AND NITROGEN LEVELS

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1. INTRODUCTION

Forages are the mainstay of animal wealth. Their production is the backbone of livestock industry. The scarcity of green forages and grazing resources in the country has made the livestock to suffer continuously with malnutrition resulting in their production potentiality at sub optimum level as compared to developed nations.

India is having the largest livestock population of 520 m heads which is about 15 per cent of the world's livestock. India accounts 55 per cent of world's buffaloes, 16 per cent of the world's cattle, 20 per cent of the world's goats and 4 per cent world's sheep population but is having only 4.4 per cent of the cultivated area under fodder crops with an annual total forage production of 833 m t (390 m t green and 443 m t dry). Whereas, the annual forage requirement is 1594 m t (1025 m t green and 569 m t dry) to support the existing livestock population. The present feed and fodder resources of the country can meet only 48 per cent of the requirement with a vast deficit of 61.1 per cent and 21.9 per cent of green and dry fodder, respectively (Anonymous, 2009).

The farmers possessing the livestock breeds with higher milk yield potential are suffering due to insufficient green and dry fodder availability in the country. To overcome this deficit, dairy farmers resort to increased use of costly concentrate feeds which increases the cost of production. It is pertinent to recall that out of the total cost of milk production, the feed cost alone accounts to 65 to 70 per cent.

Karnataka supports 28.55 million heads of livestock with only 3.5 per cent of the cultivated area under fodder crops. In Karnataka out of 19.11 m.ha of total geographical area only 0.36 m ha of land is utilised for fodder production. The annual fodder requirement in the state is 122 m t of green forage and 24 m t of dry fodder, whereas production is 85 and 15 m t of green and dry fodder, respectively, with a deficit of 46 m t of total fodder.

Although, the total milk production in India (90 mt) is the highest in the world, the productivity per animal is far below compared to the developed countries due to inadequate quality forage. In India, due to ever increasing human population and increased demand for food production continuously and increased land use for non agricultural sectors. It is not possible to increase the area under fodder crops. The only way to bridge the large gap between supply and demand of fodder is to maximize the fodder production per unit area (productivity) per unit time within the existing farming systems and utilising marginal, sub marginal dry lands and problematic soils for developing feed and fodder resources.

Maize (*Zea mays* L.) is one the most important economic crop plants and is almost an ideal cereal forage crop because of its quick growing, high yielding, palatable with nutritious qualities and lactogenic effect. The main aim of fodder maize production is to provide nutritious fodder in accordance with feed requirement of animal. Fodder cowpea when mixed with fodder maize at 15 kg ha^{-1} increases the protein content and tonnage of fodder with higher palatability. The average yield of fodder maize is about 35 to 40 t ha^{-1}. Fodder maize can be grown successfully from April to December under rainfed condition. Nitrogen is the most important major nutrient element for maize plant as it increases the vegetative growth of plant and dry matter production, which are the twin desirable qualities of an ideal fodder maize crop. Therefore, it becomes necessary to determine the optimum dose of nitrogen, which will fulfil the requirement of crop and ensure maximum returns.

Plant spacing is one the most important factor that greatly influences the potential yield of fodder maize. Generally the recommended seed rate of fodder maize is 60 kg/ha. The yield of the crop can be improved by increasing light penetration in crop canopy. In wider row spacing (less plant population), solar radiation falling within the row might be wasted particularly in early stages of crop growth. Closer row spacing with higher seed rate in fodder maize results in more interception and absorption of solar radiation and ultimately results in higher forage yield.

Application of organics like, FYM, compost, poultry manure, animal urine *etc.* increases the fodder maize yield and quality. The organics also help to maintain soil fertility. An attempt was made in the present investigation to maximize fodder maize productivity with the following objectives.

1. To evaluate the effect of higher level of organics, nitrogen and seed rate on growth, yield and quality of fodder maize.
2. To assess the interaction effect of organics, nitrogen and seed rate on growth, yield and quality of fodder maize.
3. To work out the economics of fodder maize production under different input regime.

2. REVIEW OF LITERATURE

The literature pertaining to the response of fodder maize (African Tall) to organics, seed rate and N levels on growth, yield and quality is presented in this chapter. The literature on other cereal fodder is also reviewed here as the literature on fodder maize is meagre.

Fodder maize (*Zea mays* L.) is one the most important economic crop plant and is almost an ideal cereal forage crop because of its quick growing, high yielding, palatable with nutritious qualities and lactogenic effect, it is preferred as fodder crop. As it is highly exhaustible crop, it consumes large amount of nutrients from the soil. Nitrogen is the most important major nutrient element for maize plant as it increases the vegetative growth, palatability and dry matter production and also rich in nutritional value. It is a short duration crop and can be harvested at 80 – 90 DAS (milky stage) for soilage as well as silage purpose.

Research work carried out in different parts of the country in last few years on input management on intensive scale for enhancing productivity with respect to quality of fodder maize is reviewed in this chapter.

2.1 Effect of N levels on fodder maize

2.2 Effect of organics on fodder maize

2.3 Effect of seed rate on fodder maize

2.4 Economics

2.1 Effect of N levels on fodder maize

Ogunlela *et al.* (1988) observed increased plant height and dry matter production as nitrogen fertilization increased upto 100 or 150 kg ha^{-1}. There also increased plant height, number of leaves per plant, plant dry weight and leaf area index with an increase in nitrogen rate, but did not increase NAR, CGR, or leaf area ratio.

Asare *et al.* (1989) reported that the application of nitrogen from 0 to 120 kg ha^{-1} significantly increased the crude protein content, but depressed the crude fibre content.

Schans *et al.* (1994) conducted an experiment in which fodder maize cv. SVP-PD7 and LG 2080 was sown at 2 locations on 20^{th} April and 10^{th} May in rows 37.5 or 75 cm apart and given 0, 40, 80, 120 or 200 kg N ha^{-1}. Nitrogen uptake at 8-leaf stage was higher at closer row spacing, but by the flowering and silage - making stages these differences had disappeared. The cold-tolerant cv. SVP-PD7 absorbed less N than LG 2080 when sown early but not when sown late.

Sood *et al.* (1994) reported that African Tall produced more fresh and dry yield. It yielded 3.9, 21.5 and 67.8 per cent higher fresh yield and 4.2, 20.3 and 59.3 per cent higher dry fodder over Pioneer, Parvati and Local maize, respectively. Green fodder, dry matter and crude protein yields of maize increased significantly with increasing levels of N upto 100 kg N ha^{-1}.

Jadhao *et al.* (1995) reported that African Tall and *Manjri* composite were given 0-160 kg N/ha. Green and dry fodder yield and crude protein content increased with rate of N application and were higher in African Tall than *Manjri* composite.

Nanda *et al.* (1995) studied the response of fodder maize cv. African Tall to 0-75 kg N ha^{-1} with or without seed inoculation of *Azotobacter* or *Azospirillum.* Green fodder yield and B: C ratio were highest with a combination of 75 kg N ha^{-1} and seed inoculation with *Azotobacter* or *Azospirillum* (22.0 t $^{-1}$ha and 1.37) and lowest in control (7.6t ha^{-1} and 0.07). Application of 50 kg N ha^{-1} alone gave a similar green fodder yield to application of 25 kg N ha^{-1} + seed inoculation with *Azospirillum.* Protein yield was highest with 75 kg N ha^{-1}.

Karamundi *et al.* (1998) reported that, fodder maize (Cv. South African Tall) was influenced by nitrogen and copper level involving treatment of 3 levels of Copper (0, 25 and 50 kg ha^{-1}) applied to soil in combination with 4 levels of nitrogen 0, 75, 150 and 225 kg ha^{-1}. A significant increase in the ascorbic acid content of fresh leaves was obtained with increased application of copper and nitrogen. In addition, a significant increase in protein content was also noticed with increase in levels of copper and nitrogen.

Protein content of maize was higher in treatment combining nitrogen and copper than in those with copper alone. Application of nitrogen to soil increased crude fiber content, but similarly decreased with copper application.

Verma *et al.* (1999) reported that nitrogen content in whole plant increased significantly with increasing levels of nitrogen upto 160 kg N ha^{-1}. Nitrogen uptake increased significantly with increase in nitrogen upto 120 kg N ha^{-1} and row spacing from 20 to 30 cm which further decreased during both the years.

Verma *et al.* (1999) reported that application of 120 kg N ha^{-1} recorded significantly higher dry matter yield and plant nitrogen uptake. However plant nitrogen content, number of leaves per m row length and leaf : stem ratio were significantly increased upto 160 kg N ha^{-1}. Among the different row spacing 30 cm recorded significantly higher dry matter yield, plant N content, plant N uptake and Leaf : Stem ratio except number of leaves per m row length.

Reddy and Reddy (1999) reported that increased plant height, number of leaves, grain and fodder yield of maize with increasing levels of nitrogen upto 120 kg N ha^{-1}.

Patil and Sheelvantar (2000) reported increase in nitrogen level up to 150 kg ha^{-1} increased the straw yield of sorghum during their two years investigation.

Girija Devi (2002) reported that application of nitrogen through chemical fertilizers significantly increased green forage yield over control (no nitrogen). The data further showed a linear response to nitrogen upto 100 kg ha^{-1} (36.63 t ha^{-1}) and thereafter a gradual decrease was noticed (33.68 t/ha). The dose of 125 kg N ha^{-1} gave significantly higher green and dry matter yields than the levels of 0, 25 or 50 kg ha^{-1}. But the effect of 125 kg/ha nitrogen was on par with that of 75 and 100 kg ha^{-1}. Moreover, a higher plant height, LAI and leaf : stem ratio were observed due to increased doses of nitrogen viz., 0, 25 and 50 kg N ha^{-1} to 75, 100 and 125 kg N/ha. As such it can be inferred that nitrogen dose of 75 to 125 kg N ha^{-1} is needed for maize to produce a significantly higher fodder yield. Incremental dose of nitrogen was found to increase the concentration of nitrogen in leaf and shoot.

Girija Devi (2002) reported that application of 125 kg N ha^{-1} + *Azospirillum* seed inoculation recorded highest gross return (Rs. 11988 ha^{-1}) and net return (Rs. 5573 ha^{-1}) over rest of the treatment combinations and was on par with application of 125 kg N ha^{-1} + *Azotobacter* seed inoculation (Rs. 11598 and Rs. 5183 ha^{-1}, respectively).

Sudeshkumar and Sharma (2002) reported that green and dry matter yield increased significantly with an increase in the dose of nitrogen. The application of 40, 80 and 120 kg N per ha increased the green fodder yield by 65.8, 142.6 and 186.9 per cent and dry fodder yield by 45.2, 115.1 and 146.2 per cent respectively, compared to no application of nitrogen.

Tripathi *et al.* (2002) reported that application of nitrogen (30, 60, 90 and 120 kg N ha^{-1}) under preceding cowpea grown for fodder and green manuring including *kharif* fallow indicated that the forage yield and nutrient uptake (N, P and K) of maize increased significantly higher to a level of 90 kg N ha^{-1} after green manuring of cowpea and to a level of 120 kg N ha^{-1} after fodder cowpea and fallow land. The response of fodder yield and N uptake of maize to added nitrogen application was found maximum when crop was grown after green manuring followed by fodder cowpea. The status of soil nutrients (N, P and K) improved considerably in plots receiving cowpea green manure followed by fodder cowpea and *kharif* fallow.

Girija Devi *et al.* (2002) concluded that forage yield of maize was influenced by different levels of nitrogen and biofertilizers. There were eighteen treatment combinations comprising six levels of N (0, 25, 50, 75, 100 and 125 kg N ha^{-1}) and three levels of biofertilizers (no biofertilizers, seed inoculation with *Aztobacter* and *Azospirllum*.) Results showed that the fodder maize variety African Tall produced significantly higher green forage and dry matter yield at higher dose of N. Green forage yield increased significantly up to 125 kg N/ha, while 75 and 100 kg N/ha also produced significant yield difference compared to 0, 25 and 50 kg N/ha. The biofertilizers showed no significant effect on forage maize yield.

Ayub *et al.* (2002) reported significant increase in the fodder sorghum plant height with each incremental dose of nitrogen up to 180 kg ha^{-1}.

Sudesh Kumar and Sharma (2002) reported that increase in N levels from 0 to 120 kg per ha significantly increased the plant height, number of leaves per plant and stem girth over two years of investigation under variable FYM and seed inoculation. Ram and Bhagwan Singh (2003) reported significant effect of nitrogen on plant height up to 80 kg ha^{-1}.

Purushotham *et al.* (2002) studied the effect of application of different levels of NPK (100, 75 and 50% recommended dose of fertilizer (RDF)) and sulphur (0, 20, 40 and 60 kg sulphur ha^{-1}) under irrigation during late *Rabi* seasons of 1994 and 1995. Application of 50% RDF (75:37.5:25 kg NPK ha^{-1}) was optimum for fodder maize in late *Rabi* season under irrigation. Similarly, application of 40 kg S ha^{-1} recorded significant increase in leaf area (11.1%).

Tiwana *et al.* (2003) reported significant increase in pearl millet plant height, tillers per meter row and leaf to stem ratio due to the increased N level up to 100 kg N per ha in two years investigation. Similar results were also observed using Haryana Chari – 136 as test variety for two consecutive years by Sunil Kumar *et al.* (2004).

Bhilare *et al.*(2002) reported that increasing levels of nitrogen from 30 to 120 kg ha^{-1} progressively increased the green forage and dry matter yield. The statistically highest green forage (524.89 and 510.92 q ha^{-1}) and dry matter (118.35 and 135.00 q ha^{-1}) were obtained with application of 120 kg nitrogen per ha during 1999 – 2000 and 2000 – 2001, respectively. Ayub *et al.* (2002) reported similar performance of fodder sorghum with 120 and 180 kg N ha^{-1} in terms of green fodder yield.

Nanda *et al.* (2002) studied the effect of inorganic and organic combinations of nitrogen (N) in forage maize-wheat sequence. Application of 75 % N from fertilizer + 25 % N from subabul leaves. Resulted in significantly higher green forage yield (19.22 t ha^{-1}), dry forage yield (5.00 t ha^{-1}) and crude protein yield (3.59 q ha^{-1}) in fodder maize and a net return of Rs 14 124.00 ha^{-1} in maize-wheat sequence.

Ammaji *et al.* (2002) reported that application of 120 kg N ha^{-1} recorded significantly higher plant height, leaf area index, dry matter production and green and dry fodder yield in African Tall than APFM-22. Similarly higher percentage of crude protein content was recorded with APFM-22 while higher crude fibre per cent and crude fibre yield were recorded with African Tall.

Ayub *et al.* (2003) reported that the effect of 0, 80 and 120 kg N and 75, 100 and 120 kg seed rate ha^{-1} on fodder yield quality of maize. Increase in seed rate significantly increased plant density, green fodder yield dry matter content, but decreased the number of leaves and leaf area per plant, stem diameter, ether extractable fat and ash content. Plant height, crude protein and fiber content were not influenced significantly by the seed rate.

Dudhat *et al.* (2004) reported that application of nitrogen at the rate of 0, 40, 60 and 80 kg ha^{-1} and phosphorous levels at 0, 20 and 40 kg ha^{-1} showed that added nitrogen significantly increased the green fodder yield (282.9 q ha^{-1}) and dry matter yield (61.9 q ha^{-1}) as well as net monetary returns. Application of phosphorous did not produce any significant effect.

Pushpendra Singh (2005) reported that gross return, net return and B:C ratio was significantly influenced by application of nitrogen. Among the nitrogen levels, 80 kg N per ha recorded significantly higher gross return (Rs. 65483), net returns (60023 Rs ha^{-1}) and B:C ratio (1.99) over control (55757 and 51257 Rs ha^{-1}) respectively.

Niu-RuiMing *et al.* (2005) studied the effect of different levels of N fertilizers applied as top dressing (0 as control, 34.5, 69.0, 103.5, 138.0, 172.5, and 207.0 kg N ha^{-1}) on crop yield and quality. The top dressing of N fertilizer enhanced the fodder maize and content of crude protein and amino acid in stalks. The highest fresh (45089.9 kg ha^{-1}) and dry yields (9378.7 ka ha^{-1}) were noted at 138.0 kg N ha^{-1}. The highest content of crude protein (7.84 %), true protein (1.97 %) and amino acid (0.28 %) in stalks were also, noted at 138.0 kg N kg ha^{-1}.

Agarwal *et al.* (2005) reported that growth characters *viz.,* plant height, stem thickness and number of leaves were significantly affected due to nitrogen application and showed increasing trend with increasing level of nitrogen from 0 to 150 kg ha^{-1}.

Verma *et al.* (2005) observed gradual increase in plant height and plants per meter row length with the increased N levels from 0 to 160 kg per ha.

Agarwal *et al.* (2005) reported that levels of N positively affected the yield as each incremental level produced higher yield of green fodder and dry matter over its preceding level. Application of 150 kg N ha^{-1} recorded the maximum yield of 419.3 and 127.24 q ha^{-1} green fodder and dry matter, respectively.

Anshu Chotiya and Singh (2005) reported increase the in levels of nitrogen significantly increased the green fodder and dry matter yield. Among the different levels, 80 kg N ha^{-1} proved significantly superior over 40 kg N ha^{-1}. Further, increase in N level up to 120 kg ha^{-1} did not show significant variation over 80 kg N ha^{-1}.

Singh *et al.* (2005) reported that highest net monetary returns and benefit cost ratios was obtained with the application of 100 kg N per ha (Rs. 13063 per ha and 1.62) respectively.

Eltelib *et al.* (2006) reported that, the applied nitrogen at the rate of 0, 40 and 80 kg N ha^{-1} and the phosphorous levels at 0, 50 and 100 kg ha^{-1} showed that then added nitrogenous fertilizer significantly increased the plant height, stem diameter and leaf area index (LAI), while phosphorous fertilizer application has no significant effect on growth.

Joshi and Kuldeep Kumar (2007) reported that five graded levels of nitrogen application at the rate of 0, 40, 80, 120 and 160 kg ha^{-1} and four levels of seed rate i.e 50, 60, 70 and 80 kg ha^{-1} showed that increase in each level of nitrogen from 0-120 kg ha^{-1} recorded significantly higher green fodder yield over rest of the nitrogen levels. However dry matter, crude protein and digestible dry matter increased upto 160 kg nitrogen ha^{-1}. Increase in seed rate from 50 – 60 kg ha^{-1} significantly increased dry matter, crude protein and digestible dry matter yield. However significantly increase in green fodder was upto 70 kg seeds ha^{-1}.

Ather Nadeem *et al.* (2009) reported that growth characteristics of maize like plant height, number of leaves per plant, stem diameter and leaf area were influenced significantly by nitrogen application and were increased with increase in nitrogen levels. The crude protein was also increased with increase in nitrogen levels, however crude fibre contents was decreased with increase in nitrogen levels. The growing of maize in mixture with legumes significantly reduced plant height and number of leaves per plant of maize. Dry matter yield showed significant differences and maximum dry matter yield was recorded in maize + sesbania combination (13.25 t ha^{-1}). The maize grown in mixture with sesbania may be given nitrogen at the rate of 150 kg ha^{-1} for getting higher forage yield of good quality.

Mohamed (2010) reported that application of urea gave the lowest crude protein compared with the other nitrogen sources. On the other hand, the lowest crude fiber content was recorded when plant was treated with Ammonium sulphate nitrate (ASN) fertilizer, while the highest crude fiber content was recorded only under the control. Dry and fresh forage yield, increased progressively by ASN and NPK as compared with other nitrogen (Urea, Nitrophoska) sources.

2.2 Effect of organics on fodder maize

Sharma (1983) found that significant increase in plant height and number of leaves per plant with each successive increase in the level of fertilizer. Addition of 12.0 t FYM ha^{-1} along with fertilizer levels upto 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1} significantly improved the growth characters.

Barsukov (1991) reported that the highest fresh forage yield (52.15 t ha^{-1}) and grain yield (6.72 t ha^{-1}) were obtained with combined application of compost @ 40 t ha^{-1} and NPK (120:90:150 kg ha^{-1}) over alone application of compost and NPK fertilizer.

Naidenov *et al.* (1991) reported that combination of organics (FYM, litter and crop residues) and mineral fertilizers were most effective in increasing the protein content of fodder maize.

Balsaraf and Mothite (1994) reported that application of FYM (20.0 t ha^{-1}) during *kharif* season in black soils increased the maize dry matter yield.

Application of FYM 23.0 t ha^{-1} resulted in significantly higher biomass yields of maize over control (Brinton and Seekins, 1994).

Nanjundappa *et al.* (2002) reported that, application of recommended dose of fertilizer (150:75:50 kg NPK ha^{-1}) coupled with FYM (10 tonnes ha^{-1}) recorded the highest green and dry fodder yield of fodder maize. Growth and yield parameters were also influenced favourably by application of organic or inorganic sources of nutrients.

Gangaiah (2004) reported that, application of cattle urine at 28000 liters ha^{-1} (having 336 kg N ha^{-1} on 1.2 % N basis) along with irrigation water produced comparable maize fodder yield to that of 100 kg N fertilizer indicating that total fertilizer N requirement of fodder maize may be met from recycling animal shed washing.

Oad *et al.* (2004) reported that application of 120 kg N ha^{-1} with combination of 3000 kg FYM recorded significantly higher plant height, maximum stem girth, more green leaves and highest maize fodder yield. The treatments were comprised of varying combinations of organic manure (FYM @ at the rate of 1500, 3000 and 4500 kg ha^{-1}) and inorganic fertilizers (0, 60, 90, 120 and 150 kg N ha^{-1}). The application of farmyard manure had significant effect on fodder maize yield.

Amanullah *et al.* (2007) studied the effect of organic sources on growth, yield and quality of fodder maize Cv. African Tall. There were six organic manure treatments, *i.e.* farmyard manure (FYM 25 t ha^{-1}.), poultry manure (10 t ha^{-1}), composted poultry manure (10 t ha^{-1}), FYM (12.5 t ha^{-1}) + Poultry manure (5 t ha^{-1}.) and FYM (12.5 t ha^{-1}) + composted poultry manure (5 t ha^{-1}) along with control (no organic manure) were tried. The result revealed that all the organic manure treatment recorded better growth and yield compared to control treatment. The parameters like plant height, leaf area index, dry matter production, green fodder yield, crude protein yield and in vitro dry matter digestibility, higher nutrient uptake. Composted poultry manure (alone or combined with FYM) recorded the highest yield and quality among all treatments.

Pathan *et al.* (2007) reported that in multicut oat with increased nitrogen level from 0 to 120 kg N ha^{-1}, there was significant improvement in green forage and dry matter yield. The application of 120 kg N per ha noticed significantly higher green forage (569.99 q ha^{-1}) and dry matter (117.34 q ha^{-1}) over rest of the nitrogen levels.

Prasanna Kumar *et al.* (2008) reported that application of vermicompost @ 2.5 t/ha recorded significantly higher uptake (169.34, 53.37 and 64.69 kg ha^{-1}) of nitrogen, phosphorous and potassium when compared to control and incorporation of sorghum residue @ 5 t ha^{-1} and it was on par with the rest of the treatments. This was mainly attributed to proportionate increase in dry matter production and increase in total biological yield (grain + Stover) which ultimately increased the total uptake of nutrients. Among inorganic fertilizer levels, application of 100 per cent RDF recorded significantly higher (163.92, 51.85 and 63.74 kg ha^{-1}) uptake of nitrogen, phosphorous and potassium when compared to 50 per cent RDF (127.33, 36.06 and 46.66 kg/ha respectively) and was on par with 75 per cent RDF.

Patel *et al.* (2007) reported that application of 100 per cent RDF + 10 t FYM ha^{-1} significantly increased dry matter content, crude protein and neutral detergent fiber (NDF) content of forage maize over control. Application of 75 per cent RDF + 10 t FYM ha^{-1} combination also recorded higher dry matter content and crude protein yield. The soil application of 25 kg Zinc sulphate ha^{-1} gave significantly higher dry matter content except Soil application of 25 kg Zinc ha^{-1} + Foliar application of 0.5 % Zn at 20 and 40 DAS for crude protein content and neutral detergent fiber. However, different Zinc levels had non-significant effect on the dry matter content, crude protein and neutral detergent fiber of forage maize. Hence, the application of 100 per cent RDF alone without FYM and Zinc reduced the dry matter content and crude protein content of forage maize in Zinc deficient soils of middle Gujarat.

Bhagade *et al.* (2008) reported that application of recommended dose of fertilizer coupled with farm yard manure recorded highest green and dry matter yield of maize. Substitution of N through FYM to the extent of 25 per cent and remaining 75 per cent through urea + 50 kg P_2O_5 + 50 kg K_2O proved the best treatment amongst different combination of N through FYM and urea (73.3 q ha^{-1} of dry matter and 278.7 q ha^{-1} green fodder yields).

Similarly the quality parameters like dry matter content, crude fat, crude protein, nitrogen free extract *etc*. showed significant difference with the sources of N through FYM and urea.

Kaushalya Gupta *et al.* (2008) reported that green forage and dry matter yield was significantly increased with increased levels of N from 0 to 120 kg ha^{-1}. An increase of 44.2, 66.2 and 99.8 per cent of green fodder and 19.4, 25.1 and 41.2 per cent for dry matter yield was recorded with the application of 40, 80 and 120 kg N ha^{-1} over control, respectively.

Puri and Tiwana (2008) reported that application of FYM @ 25 t ha^{-1} increased the green fodder yield (375.5 q ha^{-1}) by 10 per cent and dry matter yield (99.6 q ha^{-1}) by 11.3 per cent over no FYM (control). Tiwana *et al.* (2003) also reported 14.8 per cent higher green fodder and 11.5 per cent dry matter yield of forage sorghum with the application of 20 t FYM ha^{-1} over control. Each increment of 25 kg N ha^{-1} increased the fodder yield of maize significantly upto 100 kg N ha^{-1}. Further increase in the nitrogen level upto 125 kg N ha^{-1} increased the fodder yield of maize but could not attain the level of significance. The application of 100 kg N ha^{-1} increased the green fodder yield (383.3 q ha^{-1}) by 22.9 and 14.2 per cent and dry matter yield (100.7 q ha^{-1}) by 22.8 and 11.9 per cent over 50 and 75 kg N ha^{-1} respectively.

Rafiqul *et al.* (2010) studied the effect of biogas spent slurry on fodder maize. There were 3 different levels of biogas slurry 60 kg 70 kg and 82 kg N equivalent ha^{-1}. The parameters studied were plant height, stem circumference, number of leaves, leaf area, dry matter yield, and nutrient contents in maize fodder. Maize plant height and stem circumference were significantly ($P < 0.01$) influenced by increasing the rate of biogas slurry at 14, 28, 42, and 56 days after sowing. The number of leaves in fodder plants did not differ significantly, but leaf area significantly ($P < 0.01$) differed between the treatment groups. The highest maize fodder biomass yield was observed in T_2 (54.12 t ha^{-1}). In the case of crude protein, a significant difference ($P < 0.01$) was observed between the treatment groups and the highest value was also observed in T_2 (11.91 %). A significant difference was also observed in dry matter ($P < 0.05$) and ash ($P < 0.01$) content between the treatment groups, but not in acid detergent fiber (ADF) or neutral detergent fiber (NDF). Based on these results, it may be concluded that the application of approximately 70 kg N equivalent of biogas slurry ha^{-1} will improve the production of biomass and nutrient content in maize fodder.

2.3 Effect of seed rate on fodder maize

Nehra *et al.* (1981) reported that application of 120 kg N ha^{-1} recorded significantly higher green fodder and dry matter yield and also percentages of crude protein, crude fat, crude fibre and mineral matter over 40 kg and 80 kg N ha^{-1}. On the other hand, N.F.E (Nitrogen Free Extract) percentage was significantly reduced and nutritive ratio was narrowed down with each increase in the level of nitrogen. The seed rate of 60 and 80 kg ha^{-1} increased green and dry matter production over 40 kg seed ha^{-1}. However, the quality parameters remained unaffected, except crude fibre percentage which increased with higher seed rates.

Taneja *et al.* (1984) reported that application of 80 kg N ha^{-1} along with 60 kg seeds ha^{-1} recorded the highest green fodder yield and dry matter yield.

Dineshkumar (1986) reported that slight increasing in crude protein by application of 50 kg seeds ha^{-1} (5.73 %) to 100 kg seeds ha^{-1} (5.88 %). A similar trend was observed in crude fibre.

Channakeshava *et al.* (1995) from UAS Bangalore Hebbal, Karnataka, reported in fodder maize cv, South African Tall, the green fodder yield increased with increase in seed rate upto 125 kg ha^{-1} in 1991 and 100 kg ha^{-1} in 1992. The incremental cost benefit ratio was highest with 75 kg seeds ha^{-1}.

Ayub *et al.* (2003) studied that the effect of 0, 80 and 120 kg N ha^{-1} and 75, 100 and 120 kg seed rate ha^{-1} on fodder yield quality of maize. Based on these findings, nitrogen at 120 kg ha^{-1} and seed rate at 120 kg ha^{-1}were the best combination for getting higher green fodder yields of maize.

2.4 Economics

For practicing any recommendation, its economic viability is very important. Studies from economics point of view are most essential for knowing feasibility of any practice. Studying two FYM, two seed rate and four nitrogen levels in fodder maize is beneficial in terms of economics returns realized due to increased green fodder yield.

Channakeshava *et al.* (1995) from UAS Bangalore Hebbal, Karnataka, reported in fodder maize cv, South African Tall, the green fodder yield increased with increase in seed rate upto 125 kg ha^{-1} in 1991 and 100 kg ha^{-1} in 1992. The incremental cost benefit ratio was highest with 75 kg seeds ha^{-1}.

Singh *et al.* (2005) reported that highest net monetary returns and benefit cost ratios was obtained with the application of 100 kg N per ha (Rs. 13063 per ha and 1.62) respectively.

Pushpendra Singh and Sumeriya (2005) reported that gross return, net return and B:C ratio was significantly influenced by application of nitrogen. Among the nitrogen levels, 80 kg N per ha recorded significantly higher gross return (Rs. 65483), net returns (Rs. 60023 ha^{-1}) and B:C ratio (1.99) over control (Rs. 55757 and Rs. 51257 ha^{-1}) respectively.

3. MATERIAL AND METHODS

Present investigation on "Response of fodder maize and cowpea mixed cropping to FYM, seed rate and nitrogen levels" was undertaken during 2010 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka) under rainfed conditions. The details of materials used and methodology adopted during the investigation are explained in this chapter.

3.1 Location

The field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad under rainfed condition, during *kharif* 2010-11 in plot No. 21 of A block. Dharwad is located in Northern Transition Zone (Zone 8) of Karnataka and is situated at 15° 26' North latitude, 75° 07' East longitude and at an altitude of 678 m above mean sea level (MSL).

3.2 Soil characteristics

The soil of the experimental site was clayey. Composite soil samples were collected from 0-30 cm depth before the initiation of the experiment. Soil samples were air dried, powdered and allowed to pass through 2 mm sieve and were analysed for soil properties (Table 1). The soil was having normal pH with medium available nitrogen, medium available phosphorous and high available potassium.

3.3 Climate and weather conditions

3.3.1 Climate

The Northern transition zone (Zone - 8) of Karnataka state receives an average rainfall of 740 mm from both southwest and northeast monsoons, which is well distributed from June to November.

3.3.2 Weather during the experimental year

The monthly mean data on climatic parameters viz., rainfall, air temperature and relative humidity as recorded at meteorological observatory, Agricultural Research Station, University of Agricultural Sciences, Dharwad, during the experimental year 2010 and the mean of previous 61 (1950-2010) years are furnished in Table 2 and depicted in Fig. 1.

3.4 Previous crop grown on the experimental area

During *kharif* and *rabi* 2009-10 fodder maize was grown with recommended cultivation practices.

3.5 Experimental details

3.5.1 Treatments

There were 16 treatment combinations consisting of two levels of FYM, two levels of seed rate and four nitrogen levels. The treatment details are furnished below.

I. Organics

a) FYM10 t ha^{-1} (F_1)

b) FYM 20 t ha^{-1} (F_2)

II. Seed rate

a) 60 kg ha^{-1} (S_1)

b) 80 kg ha^{-1} (S_2)

Table 1: Physical and chemical properties of soil in the experimental site

Sl. No.	Properties	Value obtained	Methods Employed
I.	**Physical properties**		
a.	Mechanical analysis		
	Coarse sand (%)	9.30	International pipette method (Piper, 1966)
	Fine sand (%)	16.30	
	Silt (%)	11.50	
	Clay (%)	62.90	
b.	Bulk Density (Mg/m^3)	1.34	Core sampler method (Dastane, 1967)
c.	Textural class	Clayey	
II.	**Chemical properties**		
a.	Soil pH (1:2.5 soil: water)	8.2	pH meter (Piper, 1966)
b.	Electrical conductivity ($dS\ m^{-1}$)	1.27	Conductometric method (Sparks, 1996)
c.	Available nitrogen (kg/ha)	203.7	Modified Kjeldahl method (Jackson, 1973)
d.	Available P_2O_5 (kg/ha)	38.6	Olsen's method (Muhr *et al.,* 1965)
e.	Available K_2O (kg/ha)	320.3	Flame photometry (Jackson, 1973)
	Organic carbon (g /kg)	0.47	Wet oxidation method (Jackson, 1967)

III. N levels

a) 100 kg ha^{-1} (N_1)

b) 150 kg ha^{-1} (N_2)

c) 200 kg ha^{-1} (N_3)

d) 250 kg ha^{-1} (N_4)

3.5.2 Design and plan of layout

The experiment was laid out in randomised block design with factorial concept with three replications. The plan of layout is illustrated in Fig. 2. The general view of experimental crop is presented in Plate 1.

3.5.3 Plot size

Gross : 4.0 m × 3.0 m

Net : 3.6 m x 2.6 m

3.5.4 Salient features of the African Tall maize and cowpea (DFC-1)

African Tall maize belongs to the genus *Zea* and species *mays.* L which was developed at MPKV, Rahuri in 1981. It is highly palatable, nutritious and has got lactoganic effect on milch animals and can be used for silage making. It can be grown throughout the year on wide range of soil and climatic conditions. It is short duration and can be harvested at 80-90 DAS (milky stage). It can grow upto an height of 3-4 m.

Fodder cowpea variety Swad (DFC-1) was grown mixed with maize has better ability to grow under shade and has climbing ability. It can be harvested at 70 DAS with fodder maize.

3.5.5 FYM, seed rate and fertilizers

FYM : As per treatment

Seed rate : As per treatment

3.6 Cultural operations

3.6.1 Land preparation

The land was prepared by using tractor drawn cultivator once and bullock drawn harrow twice. The smoothened land was laid out according to the experimental plan.

3.6.2 Manure and fertilizer application

The common recommended dose of 75 kg P2O5 and 25 kg K2O per ha was applied. Nitrogen was applied as per treatment. The nitrogen, phosphorus and potassium were applied in the form of urea, Diammonium phosphate and Muriate of potash. At 50 per cent nitrogen and full dose of phosphorus and potassium were applied at the time of sowing in bands in small furrows opened manually adjacent to the seed line and covered with soil to avoid the losses. Remaining 50 per cent of the nitrogen was applied at 30 DAS.

3.6.3 Seeds and sowing

Certified seeds of fodder maize (Cv. African Tall) and cowpea (DFC-1) were obtained from Fodder Research and Production Scheme Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The seed lines were opened with the help of marker at 30 cm row spacing and seeds were sown manually using seed rates as per treatment in maize. A common seed rate of 15 kg ha^{-1} of cowpea was used to mix with fodder maize. The crop was sown on 19^{th} June, 2010.

3.6.4 After care

To check the weed growth and to facilitate good growth of the crop intercultivation was carried out at 15 DAS and hand weeding was carried out twice at 30 and 45 DAS.

Table 2: Monthly meteorological data for the experimental period (2010-11) and the mean of past 60 years (1950-2009) at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad

Month	Rainfall (mm)		Temperature (^{0}C)				Relative humidity (%)	
			Mean maximum		Mean minimum			
	2010-11	1950-2009	2010-11	1950-2009	2010-11	1950-2009	2010-11	1950-2009
May	63.1	80.4	34.4	33.7	22.4	21.3	63	66.5
June	63.4	114.7	28.7	28.8	21.8	22.4	75	81.0
July	155	154.1	28.6	29.0	20.8	21.0	84	87.1
August	190.7	98.0	26.9	26.9	20.7	20.0	84	85.9
September	164.9	107.0	28.1	28.5	20.2	19.9	83	82.1
October	177	127.1	30.1	30.4	19.5	18.4	77	75.6
November	92.8	33.2	29.6	30.1	19	15.9	79	68.0
December	0.6	6.4	28.9	29.2	14.1	12.6	65	63.2
January	0	0.1	29.2	29.5	12.5	14.6	59	63.1
February	21.6	1.0	30.8	31.2	14	16.3	48	51.4
March	0.8	2.2	35.2	32.4	18.6	19.5	44	55.8
April	77.4	50.2	34.9	37.3	20.2	18.8	57	75.6
Total	**1007.3**	**774.86**	-	-	-	-	-	-

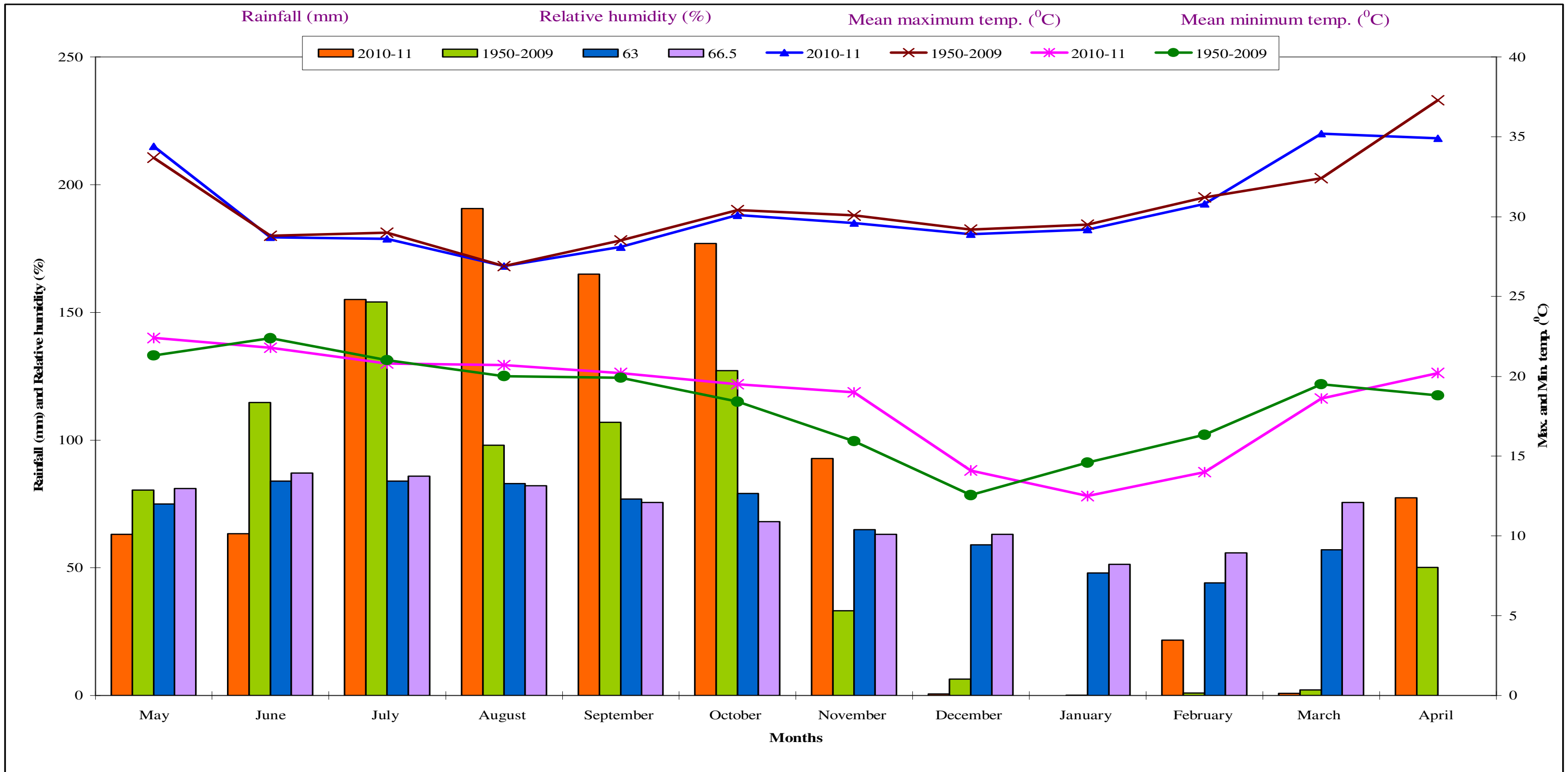

Fig. 1. Monthly meteorological data for the experimental year (2010-11) and the mean of the past 60 years (1950-2009) of the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad

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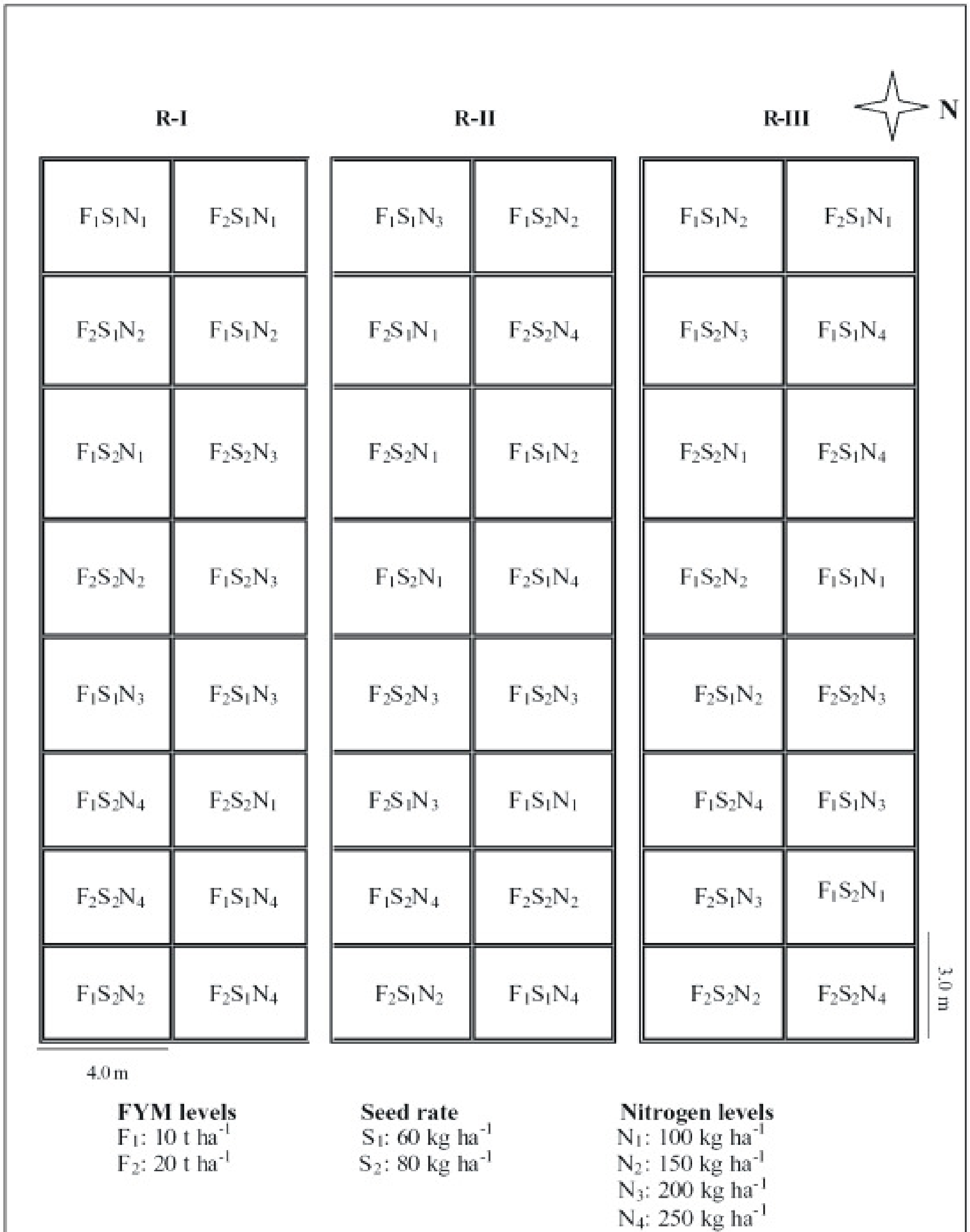

Fig. 2. Plan of layout of the experiment

Fig. 2. Plan of layout of the experiment

Plate 1: General view of the experimental plot

3.6.5 Harvesting

The crop was harvested treatment-wise at milky stage and fresh weight of fodder was recorded separately. The leaves and stalks of the sample plants were separated, dried in sun and oven dried at 70°C to a constant weight.

3.7 Collection of experimental data and plant sampling

A sample consisting of five plants was selected at random from each plot at harvest for recording various biometric observations. The procedures followed to record the observations on each parameter are presented below.

3.7.1 Plant height

The height of five plants was measured in cm from the base of the plant to the base of the fully opened youngest leaf at 30, 60 and at harvest and the average height of the plant was calculated.

3.7.2 Number of leaves per plant

Randomly five plants were selected in each treatment and fully opened leaves were counted at 30, 60 DAS and at harvest and average number of leaves per plant were calculated.

3.7.3 Number of plants per m row

Plants from each treatment at five selected spots of one m row were counted at 30, 60 DAS and at harvest and average number of plants per m row were calculated.

3.7.4 Stem girth

Randomly five plants were selected in each treatment and stem girth was recorded at maximum diameter of the stem at 30, 60 DAS and at harvest. Average stem girth was calculated.

3.7.5 Green fodder yield

On the basis of green forage yield per plot, treatment-wise green forage yield in tonnes per ha was calculated.

3.7.6 Dry matter yield

The samples drawn for dry matter accumulation studies at each harvest were utilized for calculating dry matter yield (DMY). The fresh weight of the samples were recorded and dried in hot air oven at 75^0 C for 48-72 hours to record the dry weight and dry matter percentage was determined. The plot-wise green forage yield was multiplied by respective dry matter percentage to get dry weight in kg per plot and was expressed in t ha^{-1}.

3.8 Chemical analysis for forage quality

Method of analysis

The plant samples collected at respective harvests were dried and ground to pass through one millimetre screen in a Willy grinding mill. The ground samples were taken in moisture cup and dried at 100^0 in hot air oven for overnight, cooled in a desiccator and used for further analysis on dry matter basis.

Proximate analysis

The method followed for analysis of proximate principles in forage was the one recommended by Association of Official Agriculture Chemist (A.O.A.C., 1990).

3.8.1 Crude protein

The nitrogen content of whole plant was estimated by modified microkjedhal method and expressed in percentage. The crude protein content of forage was worked out by multiplying the nitrogen percentage with factor 6.25 The crude protein yield was worked out by multiplying crude protein percentage with dry matter yield and expressed in t ha^{-1}.

3.8.2 Crude fibre

Crude fibre (CF) content in whole plant was estimated by acid-alkali digestion method and was expressed in percentage.

The crude fibre yield (CFY) was worked out by multiplying crude fibre percentage with dry matter yield and expressed in t ha^{-1}.

$$\text{CF (\%)} = \frac{\text{Weight before ashing - Weight after ashing}}{\text{Weight of the sample taken}} \times 100$$

Crude fibre yield = Crude fibre (%) x Dry matter yield.

3.8.3 Total ash

Ash is the inorganic component of the sample left after complete ignition of the sample at 600 °C in muffle furnace. The total ash was calculated by the following formula and expressed in percentage. Total ash yield was worked out by multiplying the per cent total ash with dry matter yield and expressed in t ha^{-1}.

$$\text{Total ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Total ash yield = per cent total ash x Dry matter yield

3.8.4 Ether extract

Ether extract is the crude fat component of the plant sample. It was calculated by the following formula and expressed in percentage. The ether extract yield (EEY) was worked out by multiplying the ether extract percentage with dry matter yield and expressed in t ha^{-1}.

$$\text{Ether extract (\%)} = \frac{\text{Weight of ether extract}}{\text{Weight of the sample}} \times 100$$

Ether extract yield = Per cent ether extract x Dry matter yield

3.8.5 Nitrogen free extract

Nitrogen free extract (NFE) content was calculated by the following formula and expressed in percentage. The nitrogen free extract yield was worked out by multiplying the nitrogen free extract percentage with dry matter yield and expressed in t ha^{-1}.

NFE (%) = 100 - [Crude protein (%)+ Crude fibre (%) + Ether extract (%) +Total ash (%)]

NFE Yield = Per cent NFE x Dry matter yield

3.8.6 Organic matter

Organic matter (OM) content was calculated by the formula given below and expressed in percentage. The organic matter yield was worked out by multiplying the organic matter percentage with dry matter yield and expressed in t ha^{-1}.

Organic Matter (%) = 100- Total ash (%)

Organic matter yield = Per cent organic matter x Dry matter yield.

3.8.7 Total carbohydrates

Total carbohydrate (TCHO) content was calculated by the following formula and expressed in percentage. The total carbohydrate yield (TCHOY) was worked out by multiplying the total carbohydrate percentage with dry matter yield and expressed in t ha^{-1}.

Total carbohydrate (%) = NFE (%) + Crude fibre (%)

Total carbohydrate yield = Per cent total carbohydrate x Dry matter yield.

3.9 Palatability

Palatability was studied by feeding a known weight of fresh samples from the experimental plot, treatment-wise to four to five year old cows in the morning. After two hours, the leftover sample was weighed and palatability was calculated and expressed in percentage.

$$\text{Palatability (\%)} = \frac{\text{Weight of the fresh fodder offered} - \text{Weight of the leftover fodder}}{\text{Weight of the fresh fodder offered}} \times 100$$

3.10 Economics

3.10.1 Cost of cultivation

The cost of cultivation was worked out treatment-wise. The prices of the inputs that were prevailing in the market at the time of their use and selling price for green and dry fodder and grains as approved by the University of Agricultural Sciences, Dharwad were taken into account. The details are given in Appendix I.

3.10.2 Net returns

The net retuns per ha was calculated by deducting the cost of cultivation per ha from the gross returns per hectare.

3.10.3 Benefit Cost ratio

It was worked out as follows.

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

3.11 Statistical analysis

The experimental data were statistically analysed using MSTST-C programme. The level of significance used in F test was P= 0.05. The mean value of the two factors and treatment combinations were subjected to Duncan's Multiple's Range Test (DMRT) using the corresponding error mean sum of square and degrees of freedom values (Gomez and Gomez, 1984). The means followed by the same lower case letter/s do not differ significantly at 0.05 probability level.

4. EXPERIMENTAL RESULTS

The results of the experiment conducted to study intensive input management in fodder maize (African Tall) and cowpea (DFC-1) mixture for enhancing the productivity during *kharif*, 2010 at Main Agricultural Research Station, UAS, Dharwad are presented in this chapter.

4.1 Growth components

4.1.1 Plant height (cm) (cf. Table 3)

Application of FYM @ 20 t ha^{-1} recorded significantly higher plant height (47.84, 255 and 291 cm at 30, 60 DAS and harvest respectively) of fodder maize compared to 10 t FYM ha^{-1}.

A seed rate of 80 kg ha^{-1} recorded significantly higher plant height (48.65, 258.08 and 296 cm at 30, 60 DAS and harvest respectively) compared to 60 kg seeds ha^{-1}.

Application of 250 kg N ha^{-1} recorded significantly higher plant height at 30 DAS and at harvest (49.21 and 290.75 cm respectively) over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1}. At 60 DAS, 250 kg N ha^{-1} recorded significantly higher plant height (260.98 cm) over rest of the treatments.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher plant height at 30 DAS (52.07 cm) over rest of treatment combination except $F_2S_2N_3$, $F_2S_2N_2$, $F_2S_1N_4$, $F_1S_2N_4$, $F_1S_2N_3$, and $F_1S_1N_4$ with which it was on par. At 60 DAS, FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher plant height (271.80 cm) over rest of the treatment combinations. Similar trend was observed at harvest.

4.1.2 Number of leaves per plant (cf. Table 4)

Application of FYM @ 20 t ha^{-1} recorded on par number of leaves per plant with that of 10 t ha^{-1} at 30 and 60 DAS. At harvest application of FYM @ 20 t ha^{-1} recorded significantly higher number of leaves per plant (12.33) over 10 t ha^{-1}.

A seed rate of 60 kg ha^{-1} recorded significantly higher number of leaves per plant (7.15, 9.68 and 12.67 at 30, 60 DAS and harvest respectively) over that of 80 kg ha^{-1} at all the stages of growth.

At 30 DAS application of 250 kg N ha^{-1} recorded significantly higher number of leaves per plant (7.47) compared to 100 kg and 150 kg N ha^{-1} and was on par with that of 200 kg N ha^{-1}. Similar trend was observed at 60 DAS and at harvest.

At 30 DAS, a treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher number of leaves per plant (7.60) compared to $F_2S_2N_1$, $F_1S_2N_1$ and $F_1S_2N_2$ and was on par with rest of the treatment combinations. Similar trend was observed at 60 DAS and at harvest.

4.1.3 Number of plants per m row (cf. Table 5)

Application of FYM @ 20 t ha^{-1} recorded significantly higher number of plants per m row (11.5) compared to 10 t ha^{-1} at all the stages of growth.

A seed rate of 80 kg ha^{-1} recorded significantly higher number of plants per m row (12.69) compared to 60 kg ha^{-1} at all the stages of growth.

Application of 250 kg N ha^{-1} recorded significantly higher number of plants per m row (12.5) over other N levels at all the stages of growth.

At 30 DAS, a treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher number of plants per m row (13.60) over other treatment combinations except $F_2S_2N_3$, $F_2S_2N_2$, $F_1S_2N_4$ and $F_1S_2N_3$ with which it was on par. Similar trend was observed at 60 DAS and at harvest.

Table 3. Plant height of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Plant height (cm)		
	30 DAS	60 DAS	At harvest
Farmyard manure (t/ha) (F)			
10 (F_1)	46.2 b	247.6 b	272.4 b
20 (F_2)	47.8 a	255.5 a	291 a
S.Em.$\pm$	0.11	0.11	0.34
Seed rate (kg ha^{-1}) (S)			
60 (S_1)	45.4 b	245.1 b	267 b
80 (S_2)	48.6 a	258 a	296 a
S.Em.$\pm$	0.11	0.11	0.34
Nitrogen levels (kg ha^{-1}) (N)			
100 (N_1)	44.4 c	242.4 d	272.3 c
150 (N_2)	46.4 bc	246.9 c	278.8 bc
200 (N_3)	48.1 ab	255.9 b	284.9 ab
250 (N_4)	49.2 a	260.9 a	290.7 a
S.Em.$\pm$	0.31	0.32	0.99
Interaction (F x S x N)			
$F_1S_1N_1$	42.5 f	233.7 j	256.2 i
$F_1S_1N_2$	44.6 d-f	236.9 ij	259.6 hi
$F_1S_1N_3$	46.3 b-f	247.7 fg	264.6 g-i
$F_1S_1N_4$	47.4 a-f	249.3 f	272 f-h
$F_1S_2N_1$	45.2 c-f	244.5 gh	272.4 f-h
$F_1S_2N_2$	46.2 b-f	251.7 ef	278.6 e-g
$F_1S_2N_3$	48.4 a-d	255.7 de	285.7 d-f
$F_1S_2N_4$	49.4 a-d	261.5 c	289.7 de
$F_2S_1N_1$	43.2 ef	236.9 ij	261 hi
$F_2S_1N_2$	45 c-f	240.9 hi	271.7 f-h
$F_2S_1N_3$	46.7 b-f	254.1 de	274.1 f-h
$F_2S_1N_4$	47.8 a-e	261.2 c	277.3 e-g
$F_2S_2N_1$	46.7 b-f	254.7 de	299.6 cd
$F_2S_2N_2$	49.9 a-c	258.3 cd	305.3 bc
$F_2S_2N_3$	51.1 ab	266.2 b	315 ab
$F_2S_2N_4$	52.0 a	271.8 a	323.8 a
S.Em.$\pm$	2.49	2.55	7.93

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

Table 4. Number of leaves per plant of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Number of leaves per plant		
	30 DAS	60 DAS	At harvest
Farmyard manure (t/ha) (F)			
10 (F_1)	6.96 a	9.37 a	11.95 b
20 (F_2)	6.99 a	9.37 a	12.33 a
S.Em.$\pm$	0.02	0.03	0.03
Seed rate (kg/ha) (S)			
60 (S_1)	7.15 a	9.68 a	12.67 a
80 (S_2)	6.80 b	9.06 b	11.60 b
S.Em.$\pm$	0.02	0.03	0.03
Nitrogen levels (kg/ha) (N)			
100 (N_1)	6.57 b	9.03 b	11.31 c
150 (N_2)	6.70 b	9.26 ab	11.92 b
200 (N_3)	7.17 a	9.38 ab	12.49 a
250 (N_4)	7.47 a	9.82 a	12.83 a
S.Em.$\pm$	0.04	0.06	0.05
Interaction (F x S x N)			
$F_1S_1N_1$	6.70 a-d	9.47 ab	11.40 f-h
$F_1S_1N_2$	6.80 a-d	9.70 ab	12.00 c-g
$F_1S_1N_3$	7.23 a-d	9.50 ab	12.43 b-f
$F_1S_1N_4$	7.53 ab	9.83 ab	12.70 a-d
$F_1S_2N_1$	6.40 cd	8.67 b	10.67 h
$F_1S_2N_2$	6.60 b-d	9.03 b	11.50 e-h
$F_1S_2N_3$	7.07 a-d	9.20 ab	12.27 b-f
$F_1S_2N_4$	7.33 abc	9.53 ab	12.63 a-e
$F_2S_1N_1$	6.83 a-d	9.33 ab	12.63 a-e
$F_2S_1N_2$	7.00 a-d	9.47 ab	13.10 abc
$F_2S_1N_3$	7.53 ab	9.67 ab	13.40 ab
$F_2S_1N_4$	7.60 a	10.47 a	13.70 a
$F_2S_2N_1$	6.33 d	8.63 b	10.53 h
$F_2S_2N_2$	6.40 cd	8.83 b	11.07 gh
$F_2S_2N_3$	6.83 a-d	9.13 b	11.87 d-g
$F_2S_2N_4$	7.40 ab	9.43 ab	12.30 b-f
S.Em.$\pm$	0.16	0.22	0.21

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

4.1.4 Stem girth (cm) (cf. Table 6)

Application of FYM @ 20 t ha^{-1} recorded significantly higher stem girth (6.18, 6.79 and 9.23 cm at 30, 60 and harvest respectively) compared to 10 t FYM ha^{-1}.

A seed rate of 60 kg ha^{-1} recorded significantly higher stem girth (6.34, 6.93 and 9.55 cm at 30, 60 and harvest respectively) compared to 80 kg seeds ha^{-1}.

At both 30 and 60 DAS, 250 kg N ha^{-1} recorded significantly higher stem girth (6.40 and 7.08 cm) over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1}. Similar trend was observed at harvest.

At 30 DAS, a treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher stem girth (6.63 cm) than $F_2S_2N_2$, $F_1S_2N_2$, $F_1S_2N_3$, $F_2S_2N_1$ and $F_1S_2N_1$ and was on par with rest of the treatment combinations. Similar trend was observed at 60 DAS and at harvest.

4.2 Yield

4.2.1 Green fodder yield (t ha^{-1}) (cf. Table 7 and Fig. 3)

Application of FYM @ 20 t ha^{-1} recorded significantly higher green fodder yield (67.22 t ha^{-1}) compared to 10 t ha^{-1} (63.41 t ha^{-1})

A seed rate of 80 kg ha^{-1} recorded significantly higher green fodder yield (69.88 t ha^{-1}) compared to 60 kg ha^{-1} (60.75 t ha^{-1})

Application of 250 kg N ha^{-1} recorded significantly higher green fodder yield (69.78 t ha^{-1}) over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1} (66.71 t ha^{-1})

A treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher green fodder yield (74.90 t ha^{-1}) over $F_1S_1N_1$, $F_1S_1N_2$, $F_1S_1N_3$, $F_1S_1N_4$, $F_2S_1N_1$, $F_2S_1N_2$ and $F_2S_1N_3$ and was on par with rest of the treatment combinations.

4.2.2 Dry matter yield (q ha^{-1}) (cf. Table 7 and Fig. 3)

Application of FYM @ 20 t ha^{-1} recorded significantly higher dry matter yield (18.01 t ha^{-1}) compared to 10 t ha^{-1} (17.16 t ha^{-1})

A seed rate of 80 kg ha^{-1} recorded significantly higher dry matter yield (18.99 t ha^{-1}) compared to 60 kg ha^{-1} (16.18 t ha^{-1})

Application of 250 kg N ha^{-1} recorded significantly higher dry matter yield (19.94 t ha^{-1}) over rest of the treatments.

A treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher dry matter yield (22.17 t ha^{-1}) over rest of the treatment combinations except $F_2S_2N_3$ (20.90 t ha^{-1}), $F_1S_2N_4$ (21.27 t ha^{-1}) and $F_1S_2N_3$ (18.33) with which it was on par.

4.3 Quality parameters

4.3.1 Leaf : stem ratio (cf. Table 8 and Fig. 4)

Application of FYM @ 20 t ha^{-1} recorded significantly higher Leaf : stem ratio (0.91) compared to 10 t ha^{-1} (0.89) at harvest.

A seed rate of 60 kg ha^{-1} recorded significantly higher Leaf : stem ratio (0.94) compared to 80 kg ha^{-1} (0.86) at harvest.

Application of 250 kg N ha^{-1} recorded significantly higher Leaf : stem ratio (0.97) over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1} (0.90) at harvest.

A treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher Leaf : stem ratio (1.10) over other treatment combinations except $F_1S_1N_3$ (0.92), $F_1S_1N_4$ (0.95), $F_1S_2N_4$ (0.92), $F_2S_1N_2$ (0.92) and $F_2S_1N_3$ (0.95) with which it was on par.

Table 5. Number of plants per m row of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Number of plants per m row		
	30 DAS	60 DAS	At harvest
Farmyard manure (t/ha) (F)			
10 (F_1)	11.1 b	11.1 b	11.1 b
20 (F_2)	11.5 a	11.5 a	11.5 a
S.Em.$\pm$	0.03	0.03	0.03
Seed rate (kg/ha) (S)			
60 (S_1)	10 b	9.9 b	9.9 b
80 (S_2)	12.6 a	12.6 a	12.6 a
S.Em.$\pm$	0.03	0.03	0.03
Nitrogen levels (kg/ha) (N)			
100 (N_1)	10.7 b	10.7 b	10.7 b
150 (N_2)	11 b	10.9 b	10.9 b
200 (N_3)	11.1 b	11.1 b	11.1 b
250 (N_4)	12.5 a	12.5 a	12.5 a
S.Em.$\pm$	0.05	0.05	0.05
Interaction (F x S x N)			
$F_1S_1N_1$	9.2 d	9.2 d	9.2 d
$F_1S_1N_2$	9.5 d	9.1 d	9.1 d
$F_1S_1N_3$	9.1 d	9.1 d	9.1 d
$F_1S_1N_4$	11.8 c	11.8 c	11.8 c
$F_1S_2N_1$	12.1 bc	12.1 bc	12.1 bc
$F_1S_2N_2$	12.3 bc	12.3 bc	12.3 bc
$F_1S_2N_3$	12.5 abc	12.5 abc	12.5 abc
$F_1S_2N_4$	13 ab	13 ab	13.0 ab
$F_2S_1N_1$	9.3 d	9.3 d	9.3 d
$F_2S_1N_2$	9.5 d	9.5 d	9.5 d
$F_2S_1N_3$	10 d	10 d	10 d
$F_2S_1N_4$	11 c	11.6 c	11.6 c
$F_2S_2N_1$	12.2 bc	12.2 bc	12.2 bc
$F_2S_2N_2$	12.7 abc	12.7 abc	12.7 abc
$F_2S_2N_3$	13.1 ab	13.1 ab	13.1 ab
$F_2S_2N_4$	13.6 a	13.6 a	13.6 a
S.Em.$\pm$	0.20	0.20	0.20

Means having same lower case letter/s in a column do not differ significantly by DMRT ($P = 0.05$)

Table 6. Stem girth of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Stem girth (cm)		
	30 DAS	60 DAS	At harvest
Farmyard manure (t/ha) (F)			
10 (F_1)	5.95 b	6.55 b	8.9 b
20 (F_2)	6.18 a	6.79 a	9.2 a
S.Em.±	0.02	0.20	0.02
Seed rate (kg/ha) (S)			
60 (S_1)	6.34 a	6.93 a	9.5 a
80 (S_2)	5.80 b	6.40 b	8.6 b
S.Em.±	0.015	0.20	0.02
Nitrogen levels (kg/ha) (N)			
100 (N_1)	5.79 c	6.32 c	8.6 b
150 (N_2)	5.94 bc	6.53 bc	8.9 ab
200 (N_3)	6.14 ab	6.73 b	9.2 ab
250 (N_4)	6.40 a	7.08 a	9.5 a
S.Em.±	0.09	0.32	0.05
Interaction (F x S x N)			
$F_1S_1N_1$	6. a-e	6.3 d-e	9.2 a-c
$F_1S_1N_2$	6.2 a-c	6.6 b-e	9.3 ab
$F_1S_1N_3$	6.3 a-c	6.9 a-d	9.5 ab
$F_1S_1N_4$	6.5 ab	7.2 ab	9.7 ab
$F_1S_2N_1$	5.3 f	5.9 e	7.6 d
$F_1S_2N_2$	5.4 ef	6.2 de	8.2 cd
$F_1S_2N_3$	5.5 d-f	6.3 de	8.7 bc
$F_1S_2N_4$	6.1 a-e	6.7 b-e	9.1 a-c
$F_2S_1N_1$	6.1 a-d	6.7 b-d	9.5 ab
$F_2S_1N_2$	6.2 a-c	6.9 a-d	9.6 ab
$F_2S_1N_3$	6.4 ab	7.2 a-c	9.7 ab
$F_2S_1N_4$	6.6 a	7.5 a	9.9 a
$F_2S_2N_1$	5.6 c-f	6.2 de	8.2 cd
$F_2S_2N_2$	5.8 b-f	6.4 de	8.7 bc
$F_2S_2N_3$	6.2 a-c	6.4 c-e	8.9 a-c
$F_2S_2N_4$	6.3 a-c	6.9 a-d	9.3 ab
S.Em.±	0.35	0.13	0.18

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

Table 7. Green fodder yield and Dry matter yield of fodder maize + cowpea as influenced by FYM, seed rate and nitrogen levels

Treatment	Green fodder yield (t/ha)	Dry matter yield (t/ha)
Farmyard manure (t/ha) (F)		
10 (F_1)	63.41 b	17.16 b
20 (F_2)	67.22 a	18.01 a
S.Em.±	0.17	0.395
Seed rate (kg/ha) (S)		
60 (S_1)	60.75 b	16.18 b
80 (S_2)	69.88 a	18.99 a
S.Em.±	0.17	0.395
Nitrogen levels (kg/ha) (N)		
100 (N_1)	61.03 c	15.08 d
150 (N_2)	63.76 bc	16.95 c
200 (N_3)	66.71 ab	18.38 b
250 (N_4)	69.78 a	19.94 a
S.Em.±	0.98	0.79
Interaction (F x S x N)		
$F_1S_1N_1$	53.87 fg	12.67 f
$F_1S_1N_2$	56.40 f	15.20 de
$F_1S_1N_3$	59.67 ef	17.50 bc
$F_1S_1N_4$	62.73 c-f	18.13 b
$F_1S_2N_1$	63.87 c-f	15.50 de
$F_1S_2N_2$	67.37 a-d	17.83 bc
$F_1S_2N_3$	70.23 a-c	18.33 ab
$F_1S_2N_4$	73.17 a	21.27 a
$F_2S_1N_1$	58.00 ef	14.70 e
$F_2S_1N_2$	62.00 d-f	16.27 c-e
$F_2S_1N_3$	65.00 b-e	16.80 b-d
$F_2S_1N_4$	68.30 a-d	18.20 b
$F_2S_2N_1$	68.37 a-d	17.47 bc
$F_2S_2N_2$	69.27 a-d	8.50 b
$F_2S_2N_3$	71.90 ab	20.90 a
$F_2S_2N_4$	74.90 a	22.17 a
S.Em.±	1.35	3.16

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

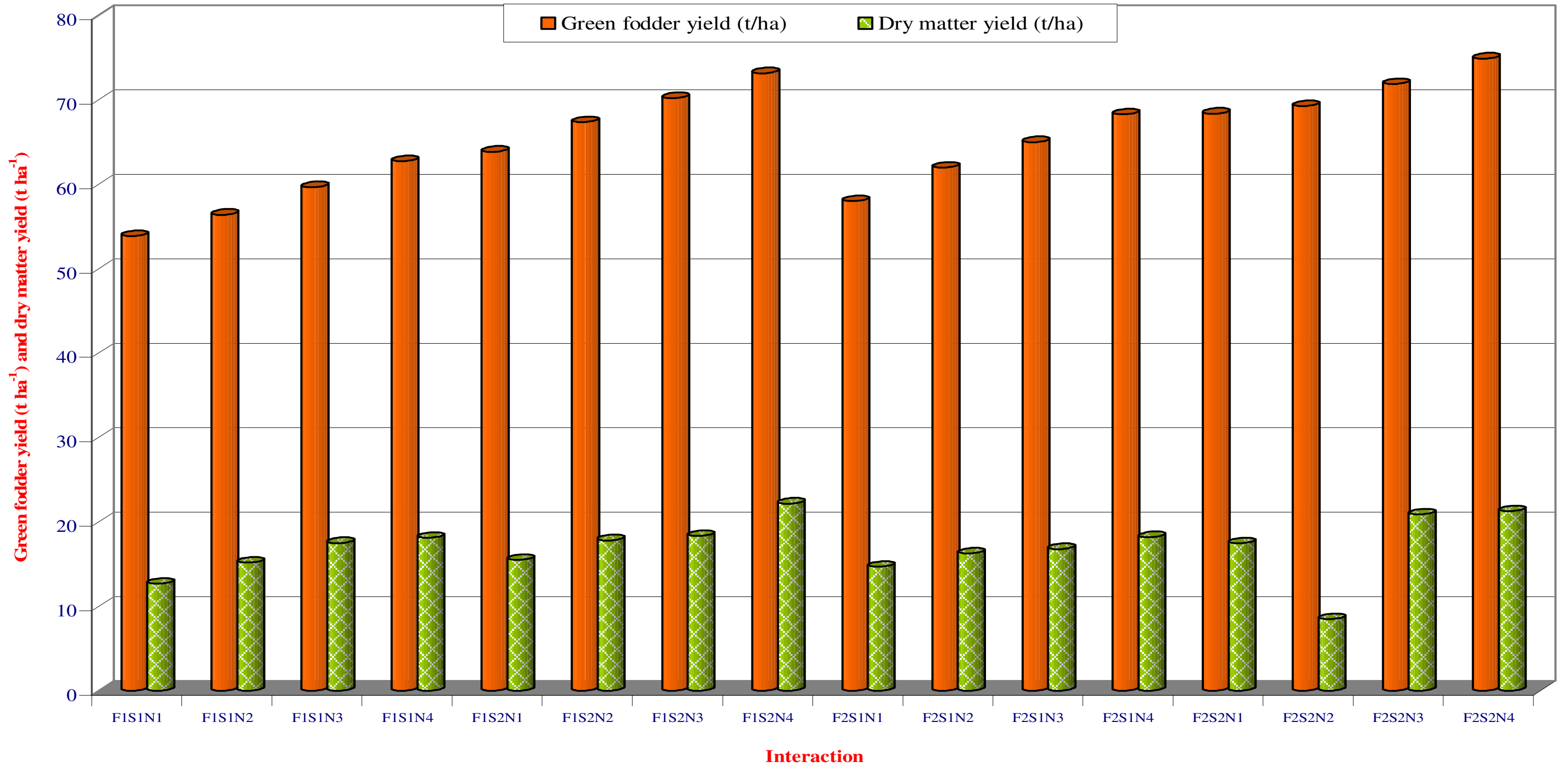

Fig. 3: Green fodder yield and Dry matter yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Fig. 3: Green fodder yield and Dry matter yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

4.3.2 Palatability (%)(cf. Table 8 and Fig. 4)

Application of FYM @ 20 t ha^{-1} recorded significantly higher palatability (99.36 %) compared to 10 t ha^{-1} (98.93 %) at harvest.

A seed rate of 80 kg ha^{-1} recorded significantly higher palatability (99.74 %) compared to 60 kg ha^{-1} (98.54 %) at harvest.

Application of 250 kg N ha^{-1} recorded significantly higher palatability (99.54 %) over rest of the treatments at harvest.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher palatability (100 %) over rest of the treatment combinations, except $F_2S_2N_3$ (99.93%), $F_2S_2N_2$ (99.85%), $F_2S_2N_1$ (99.81%), $F_1S_2N_4$ (99.98%) and $F_1S_2N_3$ (99.95%) with which it was on par.

4.3.3 Plant nitrogen uptake (%) (cf. Table 8)

Application of FYM @ 20 t ha^{-1} recorded significantly higher N uptake (1.34%)

compared to 10 t ha^{-1} (1.32%).

A seed rate of 80 kg ha^{-1} recorded on par N uptake (1.31%) with that of 60 kg ha^{-1} respectively.

Application of 250 kg N ha^{-1} recorded significantly higher N uptake (1.42%) over rest of the treatments.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher N uptake (1.44%) over rest of the treatment combinations except $F_2S_1N_4$ (1.43%) and $F_1S_2N_4$ (1.41%) with which it was on par.

4.3.4 Crude protein content (%) (cf. Table 9 and Fig. 5)

Application of FYM @ 20 t ha^{-1} recorded significantly higher crude protein content (8.40 %) compared to 10 t ha^{-1} (8.26 %)

A seed rate of 80 kg ha^{-1} recorded significantly higher crude protein content (8.18 %) compared to 60 kg ha^{-1} (8.17 %)

Application of 250 kg N ha^{-1} recorded significantly higher crude protein content (8.85 %) over rest of the treatments.

A treatment combination of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly crude protein content (9.02 %) over rest of the treatment combinations except $F_2S_2N_4$ (8.94 %) and $F_2S_1N_4$ (8.81 %) with which it was on par.

4.3.5 Crude protein yield (kg ha^{-1}) (cf. Table 9 and Fig. 5)

Application of FYM @ 20 t ha^{-1} recorded significantly higher crude protein yield (1519 kg ha^{-1}) compared to 10 t ha^{-1} (1429 kg ha^{-1})

A seed rate of 80 kg ha^{-1} recorded significantly higher crude protein yield (1619 kg ha^{-1}) compared to 60 kg ha^{-1} (1329 kg ha^{-1})

Application of 250 kg N ha^{-1} recorded significantly higher crude protein yield (1767 kg ha^{-1}) over rest of the treatments.

A treatment combination of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher crude protein yield (1999 kg ha^{-1}) over rest of the treatment combinations except $F_2S_2N_4$ (1901 kg ha^{-1}) with which it was on par.

4.3.6 Crude fibre content (%) (cf. Table 10 and Fig. 6)

Application of FYM @ 10 t ha^{-1} recorded significantly higher crude fibre content (32.05%) compared to 20 t ha^{-1} (30.80%).

A seed rate of 60 kg ha^{-1} recorded significantly higher crude fibre content (32.61 %) compared to 80 kg ha^{-1} (30.25 %).

Table 8. Leaf : stem ratio, plant N uptake and palatability of fodder maize as influenced by FYM, seed rate and nitrogen levels at harvest

Treatment	Leaf : stem ratio	Plant N uptake (%)	Palatability
Farmyard manure (t/ha) (F)			
10 (F_1)	0.89 b	1.32 b	98.93 b
20 (F_2)	0.91 a	1.34 a	99.36 a
S.Em.±	0.003	0.001	0.012
Seed rate (kg/ha) (S)			
60 (S_1)	0.94 a	1.31 a	98.54 b
80 (S_2)	0.86 b	1.31 a	99.74 a
S.Em.±	0.003	0.001	0.012
Nitrogen levels (kg/ha) (N)			
100 (N_1)	0.86 b	1.26 d	98.64 d
150 (N_2)	0.88 b	1.31 c	99.15 c
200 (N_3)	0.90 ab	1.34 b	99.24 b
250 (N_4)	0.97 a	1.42 a	99.54 a
S.Em.±	0.01	0.002	0.03
Interaction (F x S x N)			
$F_1S_1N_1$	0.88 b	1.21 i	97.47 h
$F_1S_1N_2$	0.89 b	1.24 hi	97.44 g
$F_1S_1N_3$	0.92 ab	1.32 ef	98.42 fg
$F_1S_1N_4$	0.95 ab	1.38 b-d	99.19 d
$F_1S_2N_1$	0.83 b	1.28 f-h	99.00 de
$F_1S_2N_2$	0.86 b	1.34 d-f	99.40 b-d
$F_1S_2N_3$	0.89 b	1.36 c-e	99.95 ab
$F_1S_2N_4$	0.92 ab	1.41 a-c	99.98 a
$F_2S_1N_1$	0.90 b	1.25 g-i	98.26 fg
$F_2S_1N_2$	0.92 ab	1.32 ef	99.37 cd
$F_2S_1N_3$	0.95 ab	1.32 ef	98.64 ef
$F_2S_1N_4$	1.10 a	1.43 ab	98.99 de
$F_2S_2N_1$	0.81 b	1.30 e-g	99.81 a-c
$F_2S_2N_2$	0.83 b	1.34 d-f	99.85 a-c
$F_2S_2N_3$	0.85 b	1.38 b-d	99.93 ab
$F_2S_2N_4$	0.89 b	1.44 a	100 a
S.Em.±	0.02	0.010	0.10

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

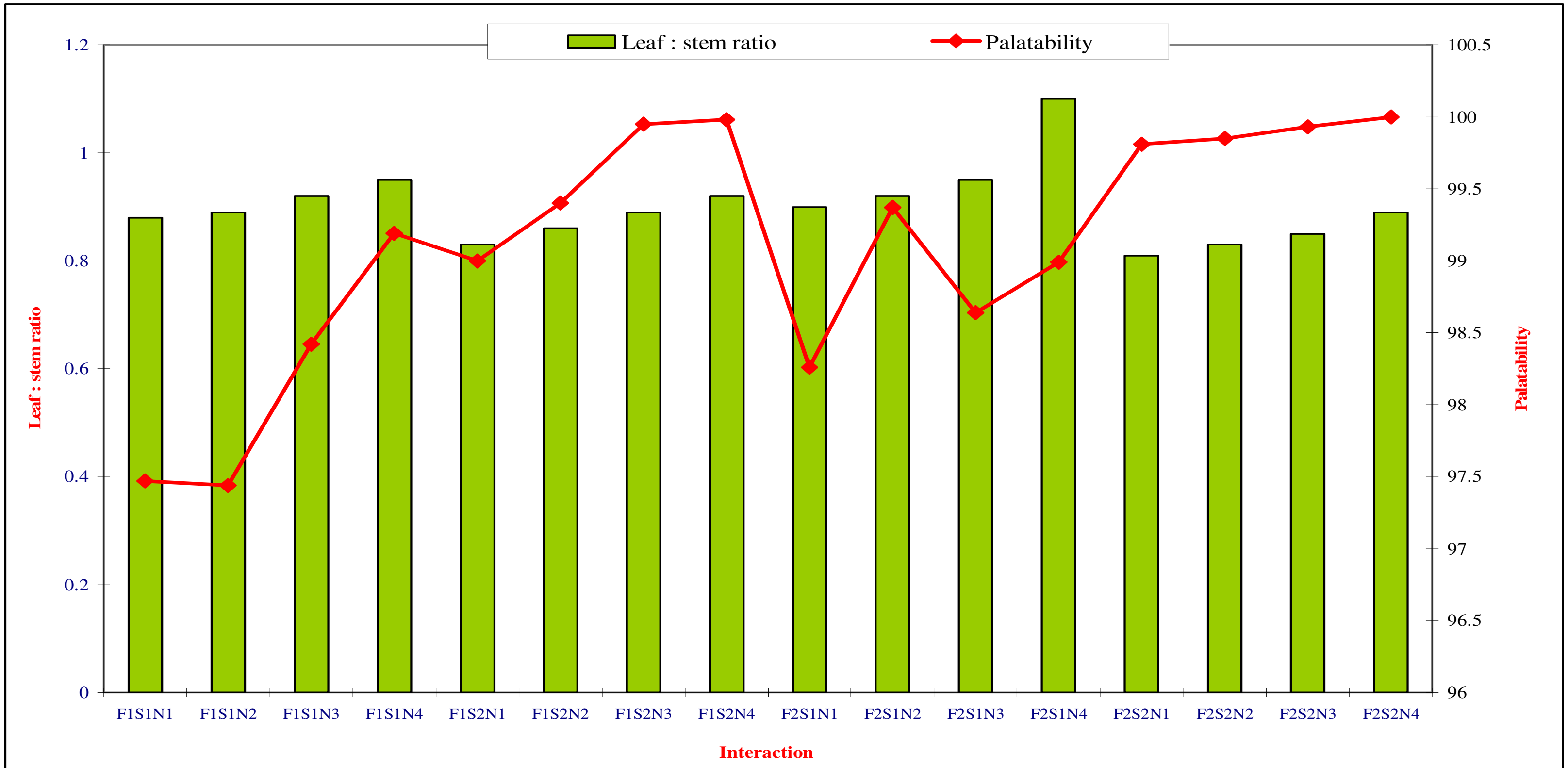

Fig. 4: Leaf : stem ratio and palatability of fodder maize as influenced by FYM, seed rate and nitrogen levels at harvest

Fig. 4: Leaf : stem ratio and palatability of fodder maize as influenced by FYM, seed rate and nitrogen levels at harvest

Table 9. Crude protein and crude protein yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Crude protein (%)	Crude protein yield (kg/ha)
Farmyard manure (t/ha) (F)		
10 (F_1)	8.26 b	1429 b
20 (F_2)	8.40 a	1520 a
S.Em.$\pm$	0.01	3.70
Seed rate (kg/ha) (S)		
60 (S_1)	8.17 b	1329 b
80 (S_2)	8.18 a	1620 a
S.Em.$\pm$	0.01	3.723
Nitrogen levels (kg/ha) (N)		
100 (N_1)	7.88 d	1193 d
150 (N_2)	8.19 c	1391 c
200 (N_3)	8.39 b	1545 b
250 (N_4)	8.85 a	1767 a
S.Em.$\pm$	0.02	7.45
Interaction (F x S x N)		
$F_1S_1N_1$	7.55 i	956 h
$F_1S_1N_2$	7.77 hi	1180 g
$F_1S_1N_3$	8.24 e-g	1442 c-e
$F_1S_1N_4$	8.63 b-d	1565 cd
$F_1S_2N_1$	8.02 gh	1243 fg
$F_1S_2N_2$	8.36 d-g	1489 c-e
$F_1S_2N_3$	8.48 c-f	1555 cd
$F_1S_2N_4$	9.02 a	1999 a
$F_2S_1N_1$	7.84 hi	1153 g
$F_2S_1N_2$	8.27 d-g	1346 ef
$F_2S_1N_3$	8.25 d-g	1385 ef
$F_2S_1N_4$	8.81 abc	1602 c
$F_2S_2N_1$	8.12 f-h	1421 de
$F_2S_2N_2$	8.38 d-g	1550 cd
$F_2S_2N_3$	8.61 b-e	1798 b
$F_2S_2N_4$	8.94 ab	1901 ab
S.Em.$\pm$	0.06	29.78

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

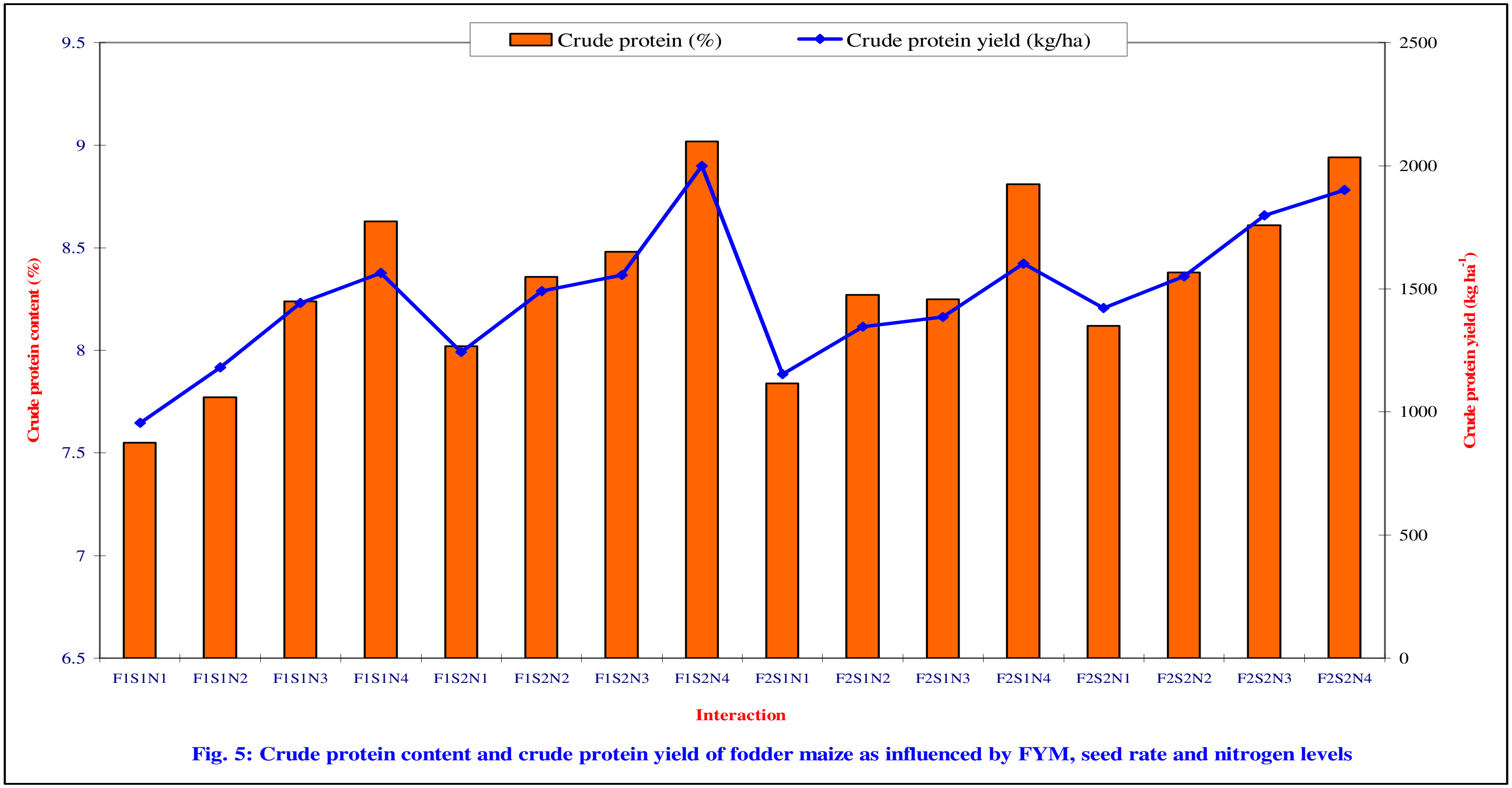

Fig. 5: Crude protein content and crude protein yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Application of 100 kg N ha^{-1} recorded significantly higher crude fibre content (34.19 %) over rest of the treatments.

A treatment combination of FYM 10 t with 60 kg seed rate at 100 kg nitrogen per ha recorded significantly higher crude fibre content (35.60 %) over other treatment combination except $F_1S_1N_2$ (34.67 %), $F_1S_2N_1$ (33.93 %), $F_2S_1N_1$ (34.63 %) and $F_2S_1N_2$ (33.20 %) with which it was on par.

4.3.7 Crude fibre yield (kg ha^{-1}) (cf. Table 10 and Fig. 6)

Application of FYM @ 20 t ha^{-1} recorded on par crude fibre yield (5497 kg ha^{-1}) to 10 t ha^{-1} (5432 kg ha^{-1})

A seed rate of 80 kg ha^{-1} recorded on par crude fibre yield (5690 kg ha^{-1}) to 60 kg ha^{-1} (5239 kg ha^{-1}).

Application of 250 kg N ha^{-1} recorded significantly higher crude fibre yield (5623 kg ha^{-1}) over 100 kg N ha^{-1}and was on par with 150 kg (5577 kg ha^{-1}) and 200 kg N ha^{-1} (5520 kg ha^{-1}).

A treatment combination of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher crude fibre yield (6089 kg ha^{-1}) over rest of the treatment combinations except $F_2S_2N_1$ (5705 kg ha^{-1}), $F_2S_2N_2$ (5805 kg ha^{-1}), $F_2S_2N_3$ (5907 kg ha^{-1}), $F_2S_2N_4$ (5572 kg ha^{-1}), $F_1S_2N_2$ (5831 kg ha^{-1}) and $F_1S_1N_3$ (5734 kg ha^{-1}) with which it was on par.

4.3.8 Total ash content (%) (cf. Table 11 and Fig. 7)

Application of FYM @ 20 t ha^{-1} recorded significantly higher total ash content (10.36 %) compared to 10 t ha^{-1} (9.99 %)

A seed rate of 80 kg ha^{-1} recorded significantly higher total ash content (10.44%) compared to 60 kg ha^{-1} (9.90 %)

Application of 250 kg N ha^{-1} recorded significantly higher total ash content (10.75 %) over rest of the treatments.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher total ash content (11.37 %) over rest of the treatment combinations.

4.3.9 Total ash yield (kg ha^{-1}) (cf. Table 11 and Fig. 7)

Application of FYM @ 20 t ha^{-1} recorded significantly higher total ash yield (1876 kg ha^{-1}) compared to 10 t ha^{-1} (1724 kg ha^{-1}).

A seed rate of 80 kg ha^{-1} recorded significantly higher total ash yield (1993 kg ha^{-1}) compared to 60 kg ha^{-1} (1607 kg ha^{-1}).

Application of 250 kg N ha^{-1} recorded significantly higher total ash yield (2147 kg ha^{-1}) over rest of the treatments.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher total ash yield (2417 kg ha^{-1}) over rest of the treatment combinations except $F_2S_2N_3$ (2268 kg ha^{-1}) and $F_1S_2N_4$ (2371 kg ha^{-1}) with which it was on par.

4.3.10 Ether extract (%)(cf. Table 12 and Fig. 8)

Application of FYM @ 20 t ha^{-1} recorded significantly higher Ether extract (2.24 %) compared to10 t ha^{-1} (2.13 %)

A seed rate of 80 kg ha^{-1} recorded significantly higher Ether extract (2.22 %) compared to 60 kg ha^{-1} (2.15 %)

Application of 250 kg N ha^{-1} recorded significantly higher ether extract (2.26 %) over rest of the treatments.

Table 10. Crude fibre and crude fibre yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Crude fibre (%)	Crude fibre yield (kg/ha)
Farmyard manure (t/ha) (F)		
10 (F_2)	32.05 a	5432 a
20 (F_1)	30.80 b	5497 a
S.Em.±	0.06	68.16
Seed rate (kg/ha) (S)		
60 (S_1)	32.61	5239 b
80 (S_2)	30.25	5690 a
S.Em.±	0.06	68.16
Nitrogen levels (kg/ha) (N)		
100 (N_1)	34.19 a	5138 b
150 (N_2)	33.03 b	5577 a
200 (N_3)	30.16 c	5520 a
250 (N_4)	28.33 d	5623 a
S.Em.±	0.11	96.39
Interaction (F x S x N)		
$F_1S_1N_1$	35.60 a	4504 e
$F_1S_1N_2$	34.67 ab	5269 b-d
$F_1S_1N_3$	32.83 b-d	5734 abc
$F_1S_1N_4$	29.90 e-g	5416 b-d
$F_1S_2N_1$	33.93 abc	5265 b-d
$F_1S_2N_2$	32.77 b-d	5831 ab
$F_1S_2N_3$	29.23 e-g	5348 b-d
$F_1S_2N_4$	27.50 gh	6089 a
$F_2S_1N_1$	34.63 ab	5078 b-d
$F_2S_1N_2$	33.20 abc	5401 b-d
$F_2S_1N_3$	30.30 d-f	5093 cd
$F_2S_1N_4$	29.73 e-g	5477 b-d
$F_2S_2N_1$	32.60 e-g	5705 a-d
$F_2S_2N_2$	31.47 c-e	5805 ab
$F_2S_2N_3$	28.27 f-h	5907 ab
$F_2S_2N_4$	26.20 h	5572 a-d
S.Em.±	0.46	556.79

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

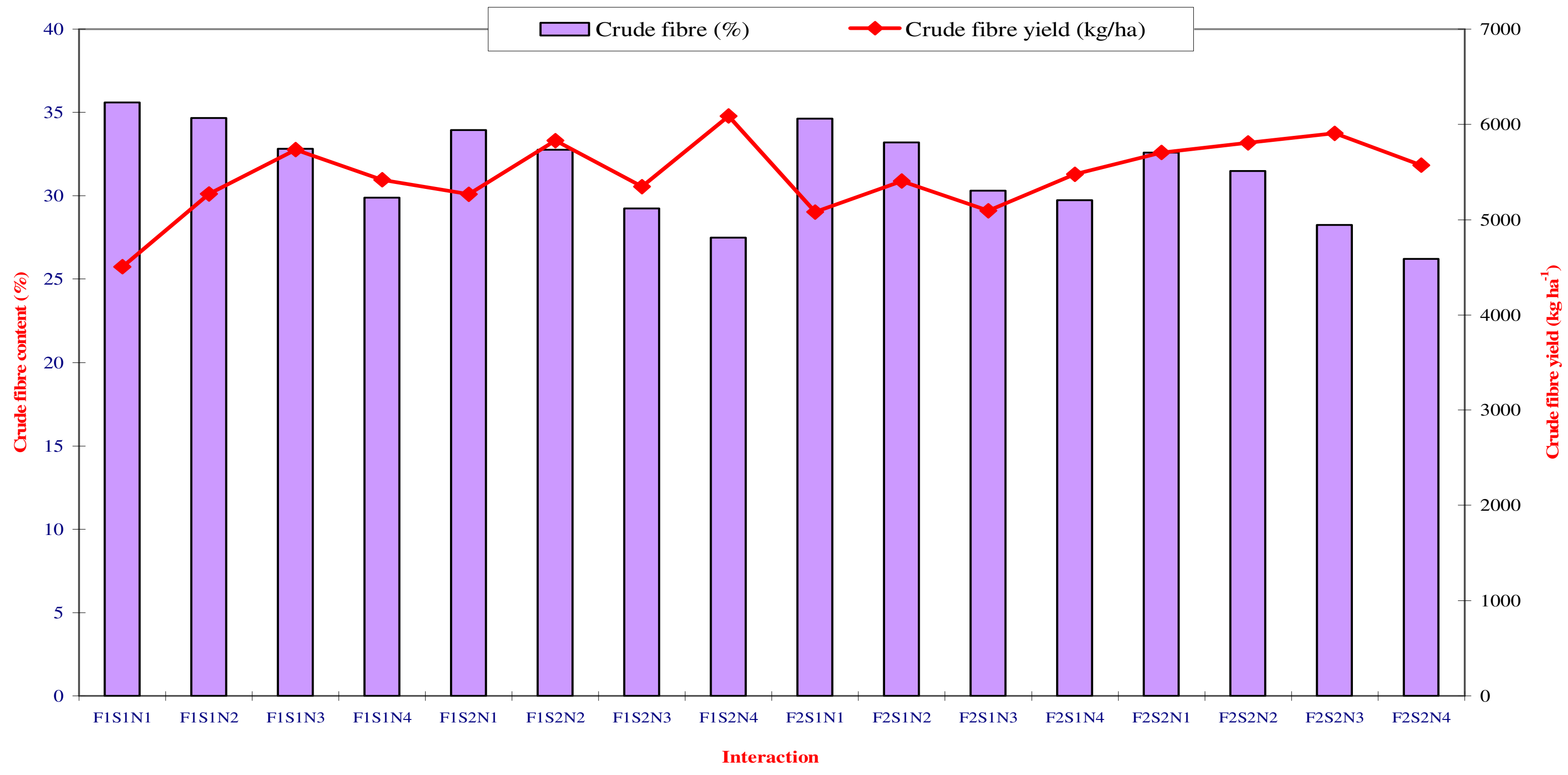

Fig. 6: Crude fibre content and crude fibre yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Fig. 6: Crude fibre content and crude fibre yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Table 11. Total ash and total Ash yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Total ash (%)	Total ash yield (kg/ha)
Farmyard manure (t/ha) (F)		
10 (F_1)	9.99 b	1724 b
20 (F_2)	10.36 a	1876 a
S.Em.±	0.01	4.09
Seed rate (kg/ha) (S)		
60 (S_1)	9.90 b	1607 b
80 (S_2)	10.44 a	1993 a
S.Em.±	0.01	4.09
Nitrogen levels (kg/ha) (N)		
100 (N_1)	9.69 d	1465 d
150 (N_2)	9.98 c	1695 c
200 (N_3)	10.27 b	1893 b
250 (N_4)	10.75 a	2147 a
S.Em.±	0.02	8.18
Interaction (F x S x N)		
$F_1S_1N_1$	9.41 f	1192 i
$F_1S_1N_2$	9.59 ef	1457 gh
$F_1S_1N_3$	9.87 de	1726 de
$F_1S_1N_4$	10.34 c	1875 b-d
$F_1S_2N_1$	9.78 de	1515 f-h
$F_1S_2N_2$	9.88 de	1761 c-e
$F_1S_2N_3$	10.33 c	1895 b-d
$F_1S_2N_4$	10.70 b	2371 a
$F_2S_1N_1$	9.56 ef	1404 h
$F_2S_1N_2$	9.83 de	1597 e-g
$F_2S_1N_3$	10.01 d	1682 ef
$F_2S_1N_4$	10.58 bc	1927 bc
$F_2S_2N_1$	10.01 d	1749 c-e
$F_2S_2N_2$	10.63 bc	1966 b
$F_2S_2N_3$	10.86 b	2268 a
$F_2S_2N_4$	11.37 a	2417 a
S.Em.±	0.06	32.73

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

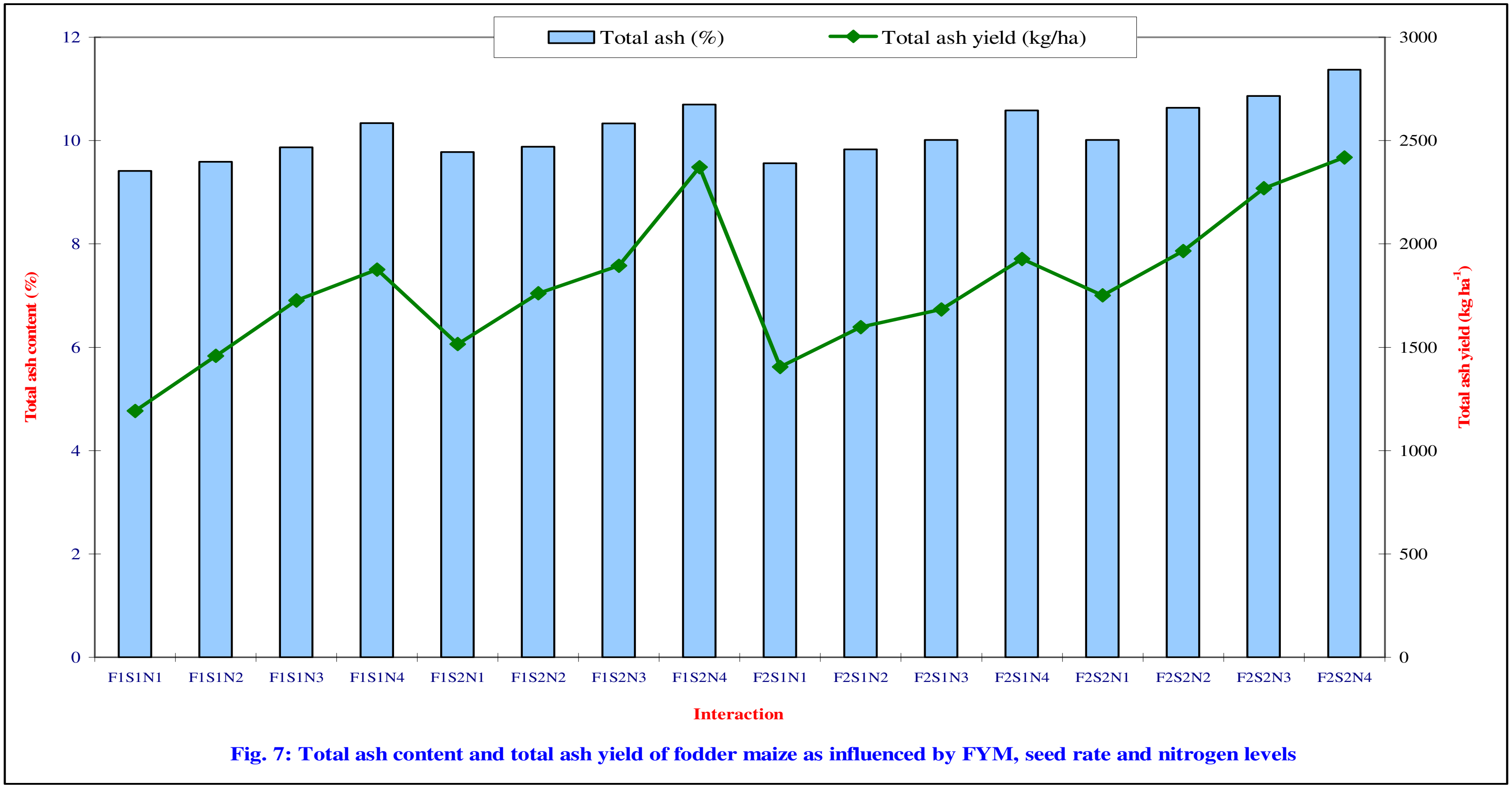

Fig. 7: Total ash content and total ash yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher ether extract (2.38 %) over rest of the treatment combinations.

4.3.11 Ether extract yield (kg ha^{-1}) (cf. Table 12 and Fig. 8)

Application of FYM @ 20 t ha^{-1} recorded significantly higher ether extract yield (405 kg ha^{-1}) compared to 10 t ha^{-1} (367 kg ha^{-1}).

A seed rate of 80 kg ha^{-1} recorded significantly higher ether extract yield (423 kg ha $^{-}$1) compared to 60 kg ha^{-1} (349 kg ha^{-1})

Application of 250 kg N ha^{-1} recorded significantly higher ether extract yield (451 kg ha^{-1}) over rest of the treatments.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher ether extract yield (506 kg ha^{-1}) over rest of the treatment combinations except $F_2S_2N_3$ (483 kg ha^{-1}) and $F_1S_2N_4$ (492 kg ha^{-1}) with which it was on par.

4.3.12 Nitrogen free extract (%) (cf. Table 13 and Fig. 9)

Application of FYM @ 20 t ha^{-1} recorded significantly higher nitrogen free extract (48.20 %) compared to 10 t ha^{-1} (47.57 %).

A seed rate of 80 kg ha^{-1} recorded significantly higher nitrogen free extract (48.60 %) compared to 60 kg ha^{-1} (47.17 %).

Application of 250 kg N ha^{-1} recorded significantly higher nitrogen free extract (49.81 %) over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1} (48.96 %)

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher nitrogen free extract (51.10%) then rest of the treatment combinations except $F_1S_1N_4$ (48.95%), $F_1S_2N_3$ (49.76%), $F_1S_2N_4$ (50.57%), $F_2S_1N_3$ (49.22%), $F_2S_1N_4$ (48.62%) and $F_2S_2N_3$ (49.96%) with which it was on par.

4.3.13 Nitrogen free extract yield (kg ha^{-1}) (cf. Table 13 and Fig. 9)

Application of FYM @ 20 t ha^{-1} recorded significantly higher nitrogen free extract yield (4819 kg ha^{-1}) compared to 10 t ha^{-1} (4756 kg ha^{-1})

A seed rate of 80 kg ha^{-1} recorded significantly higher nitrogen free extract yield (4859 kg ha $^{-}$1) compared to 60 kg ha^{-1} (4716 kg ha^{-1})

Application of 250 kg N ha^{-1} recorded significantly higher nitrogen free extract yield (4980 kg ha^{-1}) over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1} (4896 kg ha^{-1})

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher nitrogen free extract yield (5110 kg ha^{-1}) over rest of the treatment combinations except $F_1S_1N_4$ (4895 kg ha^{-1}), $F_1S_2N_3$ (4976 kg ha^{-1}), $F_1S_2N_4$ (5056 kg ha^{-1}), $F_2S_1N_3$ (4922 kg ha^{-1}), $F_2S_1N_4$ (4861 kg ha^{-1}) and $F_2S_2N_3$ (4995 kg ha^{-1}) with which it was on par.

4.3.14 Total carbohydrate content (%)(cf. Table 14 and Fig. 10)

Application of FYM @ 10 t ha^{-1} recorded significantly higher total carbohydrate content (79.62%) compared to 20 t ha^{-1} (79.00%)

A seed rate of 60 kg ha^{-1} recorded significantly higher total carbohydrate content (79.78%) compared to 80 kg ha^{-1} (78.84%)

Application of 100 kg N ha^{-1} recorded significantly higher total carbohydrate content (80.33%) over rest of the treatments.

A treatment combination of FYM 10 t with 60 kg seed rate at 100 kg nitrogen per ha recorded significantly higher total carbohydrate content (81.02%) over rest of the treatment combinations.

Table 12. Ether extract content and Ether extract yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Ether extract (%)	Ether extract yield (kg/ha)
Farmyard manure (t/ha) (F)		
10 (F_1)	2.13 b	367 b
20 (F_2)	2.24 a	405 a
S.Em.±	0.002	0.91
Seed rate (kg/ha) (S)		
60 (S_1)	2.15 b	349 b
80 (S_2)	2.22 a	423 a
S.Em.±	0.002	0.92
Nitrogen levels (kg/ha) (N)		
100 (N_1)	2.10 d	317 d
150 (N_2)	2.17 c	368 c
200 (N_3)	2.22 b	408 b
250 (N_4)	2.26 a	451 a
S.Em.±	0.004	1.83
Interaction (F x S x N)		
$F_1S_1N_1$	2.02 j	255 g
$F_1S_1N_2$	2.10 h	319 ef
$F_1S_1N_3$	2.14 f	375 cd
$F_1S_1N_4$	2.18 e	394 b-d
$F_1S_2N_1$	2.06 i	319 ef
$F_1S_2N_2$	2.14 f	380 b-d
$F_1S_2N_3$	2.19 e	401 bc
$F_1S_2N_4$	2.22 d	492 a
$F_2S_1N_1$	2.12 g	312 f
$F_2S_1N_2$	2.18 e	354 de
$F_2S_1N_3$	2.22 d	373 cd
$F_2S_1N_4$	2.26 c	411 bc
$F_2S_2N_1$	2.19 e	382 b-d
$F_2S_2N_2$	2.26 c	418 b
$F_2S_2N_3$	2.31 b	483 a
$F_2S_2N_4$	2.38 a	506 a
S.Em.±	0.02	7.33

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

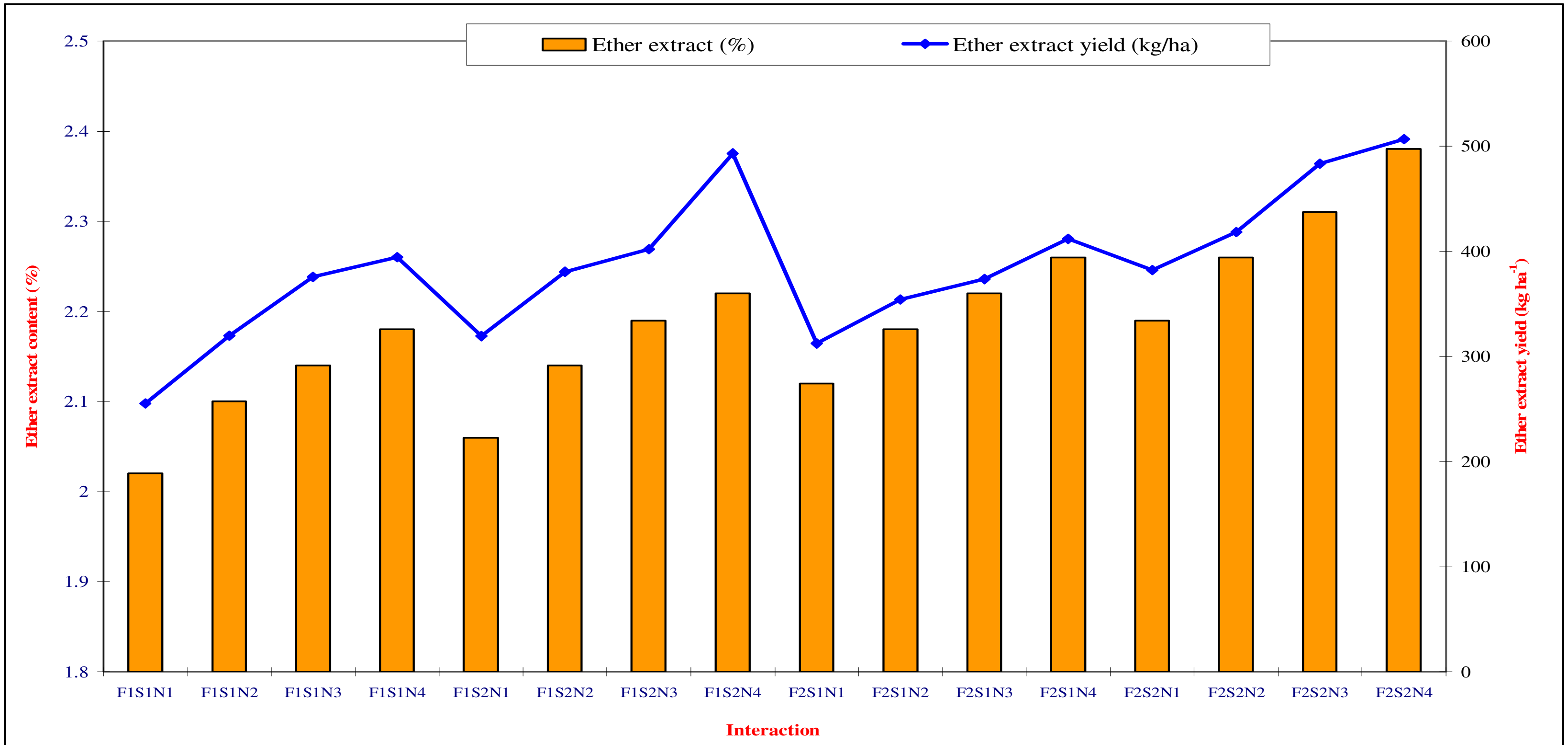

Fig. 8: Ether extract and Ether extract yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Fig. 8: Ether extract and Ether extract yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Table 13. Nitrogen free extract content and nitrogen free extract yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Nitrogen free extract (%)	Nitrogen free extract yield (kg/ha)
Farmyard manure (t/ha) (F)		
10 (F_1)	47.57 b	4756 b
20 (F_2)	48.20 a	4819 a
S.Em.±	0.06	5.88
Seed rate (kg/ha) (S)		
60 (S_1)	47.17 b	4716 b
80 (S_2)	48.60 a	4859 a
S.Em.±	0.06	5.88
Nitrogen levels (kg/ha) (N)		
100 (N_1)	46.14 b	4613 b
150 (N_2)	46.63 b	4662 b
200 (N_3)	48.96 a	4896 a
250 (N_4)	49.81 a	4980 a
S.Em.±	0.12	11.75
Interaction (F x S x N)		
$F_1S_1N_1$	45.42 e	4541 e
$F_1S_1N_2$	45.87 e	4587 e
$F_1S_1N_3$	46.91 c-e	4691 c-e
$F_1S_1N_4$	48.95 abc	4895 abc
$F_1S_2N_1$	46.21 de	4620 de
$F_1S_2N_2$	46.86 c-e	4685 c-e
$F_1S_2N_3$	49.76 ab	4976 ab
$F_1S_2N_4$	50.57 a	5056 a
$F_2S_1N_1$	45.84 e	4583 e
$F_2S_1N_2$	46.52 c-e	4652 de
$F_2S_1N_3$	49.22 abc	4922 abc
$F_2S_1N_4$	48.62 a-d	4861 a-d
$F_2S_2N_1$	47.08 c-e	4707 c-e
$F_2S_2N_2$	47.26 b-e	4725 b-e
$F_2S_2N_3$	49.96 a	4995 a
$F_2S_2N_4$	51.10 a	5110 a
S.Em.±	0.47	46.99

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

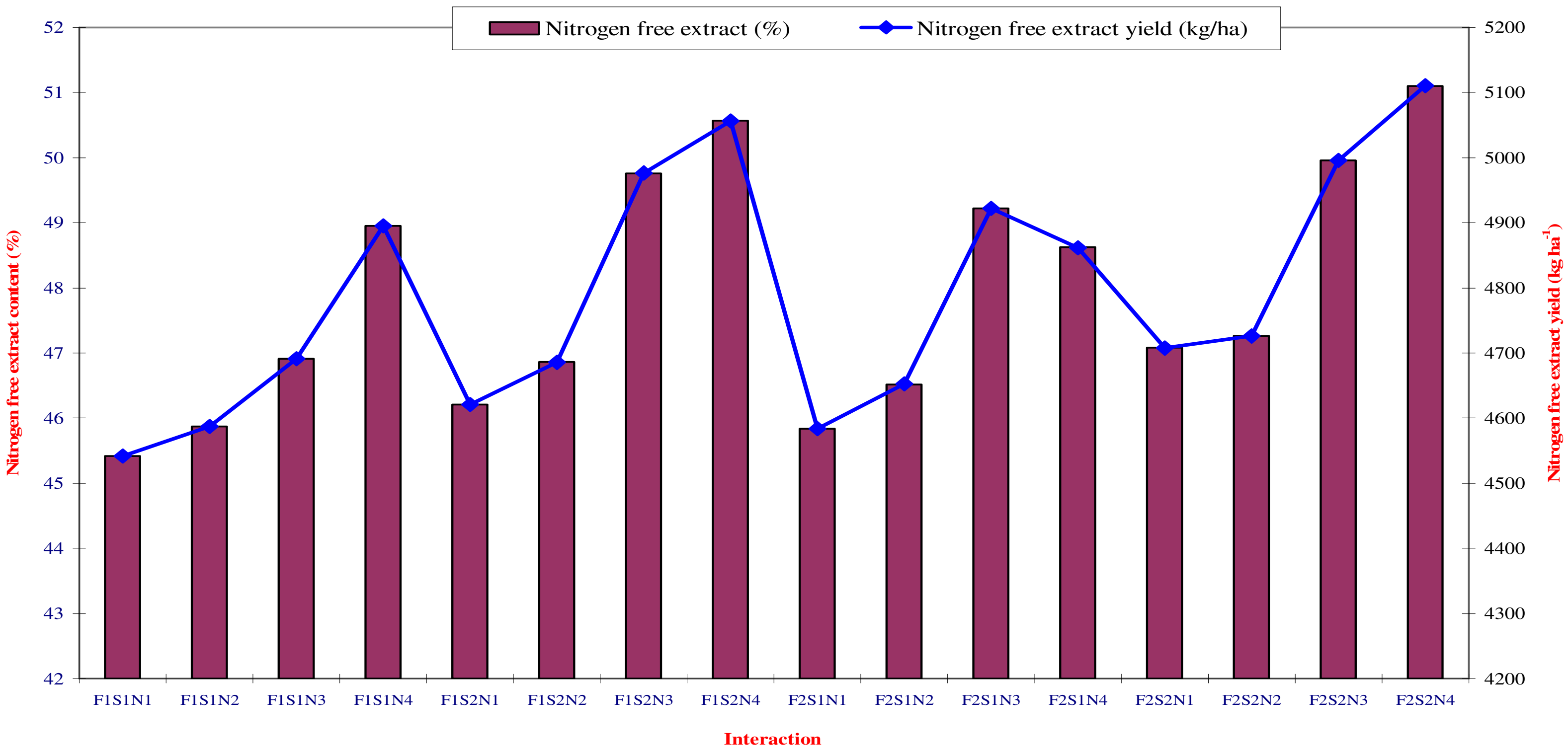

Fig. 9: Nitrogen free extract and nitrogen free extract yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Fig. 9: Nitrogen free extract and nitrogen free extract yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

4.3.15 Total carbohydrate yield (kg ha^{-1}) (cf. Table 14 and Fig. 10)

Application of FYM @ 10 t ha^{-1} recorded significantly higher total carbohydrate yield (7962 kg ha^{-1}) compared to 20 t ha^{-1} (7899 kg ha^{-1})

A seed rate of 60 kg ha^{-1} recorded significantly higher total carbohydrate yield (7977 kg ha $^{-1}$) compared to 80 kg ha^{-1} (7884 kg ha^{-1})

Application of 100 kg N ha^{-1} recorded significantly higher total carbohydrate yield (8032 kg ha^{-1}) over other treatments.

A treatment combination of FYM 10 t with 60 kg seed rate at 100 kg nitrogen per ha recorded significantly higher total carbohydrate yield (8101 kg ha^{-1}) over rest of the treatment combinations.

4.3.16 Organic matter content (%) (cf. Table 15 and Fig. 11)

Application of FYM @ 10 t ha^{-1} recorded significantly higher organic matter content (90.01%) compared to 20 t ha^{-1} (89.64%)

A seed rate of 60 kg ha^{-1} recorded significantly higher organic matter content (9.10%) compared to 80 kg ha^{-1} (89.56%)

Application of 100 kg N ha^{-1} recorded significantly higher organic matter content (90.31%) over rest of the treatments.

A treatment combination of FYM 10 t with 60 kg seed rate at 100 kg nitrogen per ha recorded significantly higher organic matter content (90.59%) over rest of the treatment combinations except $F_1S_1N_2$ (90.41%) and $F_2S_1N_1$ (90.44%) with which it was on par.

4.3.17 Organic matter yield (kg ha^{-1}) (cf. Table 15 and Fig. 11)

Application of FYM @ 20 t ha^{-1} recorded significantly higher organic matter yield (16135 kg ha^{-1}) compared to 10 t ha^{-1} (15442 kg ha^{-1})

A seed rate of 80 kg ha^{-1} recorded significantly higher organic matter yield (17002 kg ha -1) compared to 60 kg ha^{-1} (14575 kg ha^{-1})

Application of 250 kg N ha^{-1} recorded significantly higher organic matter yield (17793 kg ha^{-1}) over rest of the treatments.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher organic matter yield (19795 kg ha^{-1}) over rest of the treatment combinations except $F_1S_2N_4$ (18848 kg ha^{-1}) and $F_2S_2N_3$ (18631 kg ha^{-1}) with which it was on par.

4.3.18 Available nitrogen in soil after harvest of crop (kg ha^{-1}) (cf. Table 16)

Application of FYM @ 20 t ha^{-1} recorded significantly higher available nitrogen (198 kg ha^{-1}) compared to 10 t ha^{-1} (191 kg ha^{-1})

A seed rate of 60 kg ha^{-1} recorded significantly higher available nitrogen (204 kg ha^{-1}) compared to 80 kg ha^{-1} (190 kg ha^{-1})

Application of 250 kg N ha^{-1} recorded significantly higher available nitrogen (208 kg ha^{-1}) over rest of the treatments.

A treatment combination of FYM 10 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher available nitrogen (227 kg ha^{-1}) over rest of the treatment combinations except $F_1S_1N_3$ (223 kg ha^{-1}) with which it was on par.

4.3.19 Organic carbon content (%) in soil after harvest of crop (cf. Table 16)

Application of FYM @ 20 t ha^{-1} recorded significantly higher organic carbon content (0.56%) compared to 10 t ha^{-1} (0.55%)

A seed rate of 80 kg ha^{-1} recorded on par organic carbon content (0.56%) with that of 60 kg ha^{-1} (0.56%).

Table 14. Total carbohydrate content and total carbohydrate yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Total carbohydrate (%)	Total carbohydrate (kg/ha)
Farmyard manure (t/ha) (F)		
10 (F_1)	79.62 a	7962 a
20 (F_2)	79.00 b	7899 b
S.Em.±	0.01	0.72
Seed rate (kg/ha) (S)		
60 (S_1)	79.78 a	7977 a
80 (S_2)	78.84 b	7884 b
S.Em.±	0.01	0.72
Nitrogen levels (kg/ha) (N)		
100 (N_1)	80.33 a	8032 a
150 (N_2)	79.65 b	7965 b
200 (N_3)	79.12 c	7912 c
250 (N_4)	78.14 d	7814 d
S.Em.±	0.01	1.40
Interaction (F x S x N)		
$F_1S_1N_1$	81.02 a	8101 a
$F_1S_1N_2$	80.54 b	8053 b
$F_1S_1N_3$	79.74 d	7974 d
$F_1S_1N_4$	78.85 e	7885 e
$F_1S_2N_1$	80.14 c	8014 c
$F_1S_2N_2$	79.62 d	7962 d
$F_1S_2N_3$	79.00 e	7899 e
$F_1S_2N_4$	78.07 f	7806 f
$F_2S_1N_1$	80.47 b	8047 b
$F_2S_1N_2$	79.72 d	7972 d
$F_2S_1N_3$	79.52 d	7952 d
$F_2S_1N_4$	78.35 f	7835 f
$F_2S_2N_1$	79.68 d	7967 d
$F_2S_2N_2$	78.73 e	7872 e
$F_2S_2N_3$	78.23 f	7822 f
$F_2S_2N_4$	77.30 g	7730 g
S.Em.±	0.06	5.77

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

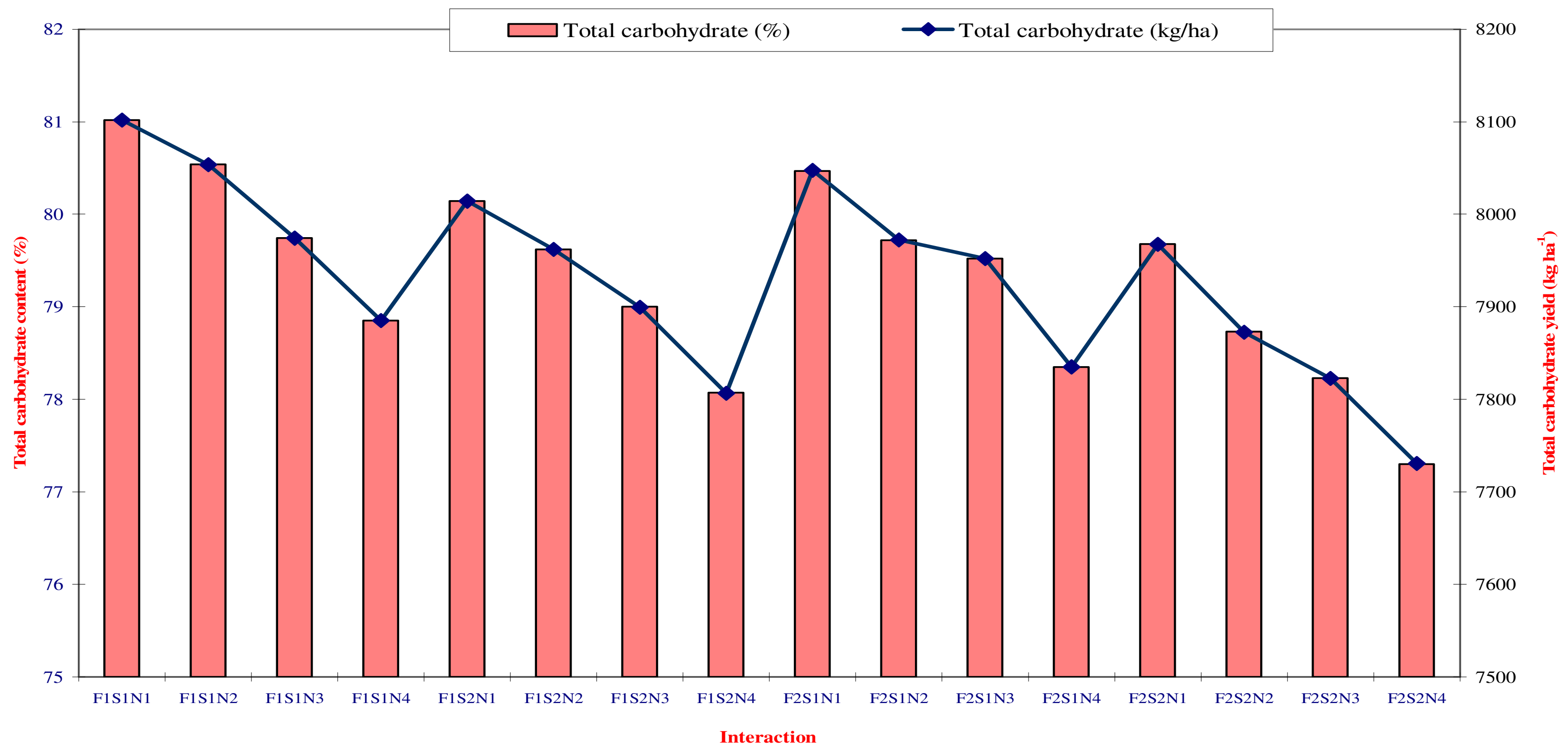

Fig. 10: Total carbohydrate content and total carbohydrate yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Fig. 10: Total carbohydrate content and total carbohydrate yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Table 15. Organic matter content and organic matter yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Organic matter (%)	Organic matter yield (kg/ha)
Farmyard manure (t/ha) (F)		
10 (F_1)	90.01 a	15442 b
20 (F_2)	89.64 b	16135 a
S.Em.$\pm$	0.06	35.69
Seed rate (kg/ha) (S)		
60 (S_1)	90.10 a	14575 b
80 (S_2)	89.56 b	17002 a
S.Em.$\pm$	0.06	35.69
Nitrogen levels (kg/ha) (N)		
100 (N_1)	90.31 a	13617 d
150 (N_2)	90.02 b	15254 c
200 (N_3)	89.73 c	16490 b
250 (N_4)	89.25 d	17793 a
S.Em.$\pm$	0.02	71.38
Interaction (F x S x N)		
$F_1S_1N_1$	90.59 a	11474 f
$F_1S_1N_2$	90.41 ab	13742 de
$F_1S_1N_3$	90.13 bc	15773 bc
$F_1S_1N_4$	89.66 d	16258 bc
$F_1S_2N_1$	90.22 bc	13984 de
$F_1S_2N_2$	90.12 bc	16072 bc
$F_1S_2N_3$	89.67 d	16438 b
$F_1S_2N_4$	89.30 e	18848 a
$F_2S_1N_1$	90.44 ab	13295 e
$F_2S_1N_2$	90.17 bc	14669 c-e
$F_2S_1N_3$	89.99 c	15117 b-d
$F_2S_1N_4$	89.42 de	16272 bc
$F_2S_2N_1$	89.99 c	15716 bc
$F_2S_2N_2$	89.37 de	16533 b
$F_2S_2N_3$	89.14 e	18631 a
$F_2S_2N_4$	88.63 f	19795 a
S.Em.$\pm$	0.06	285.53

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

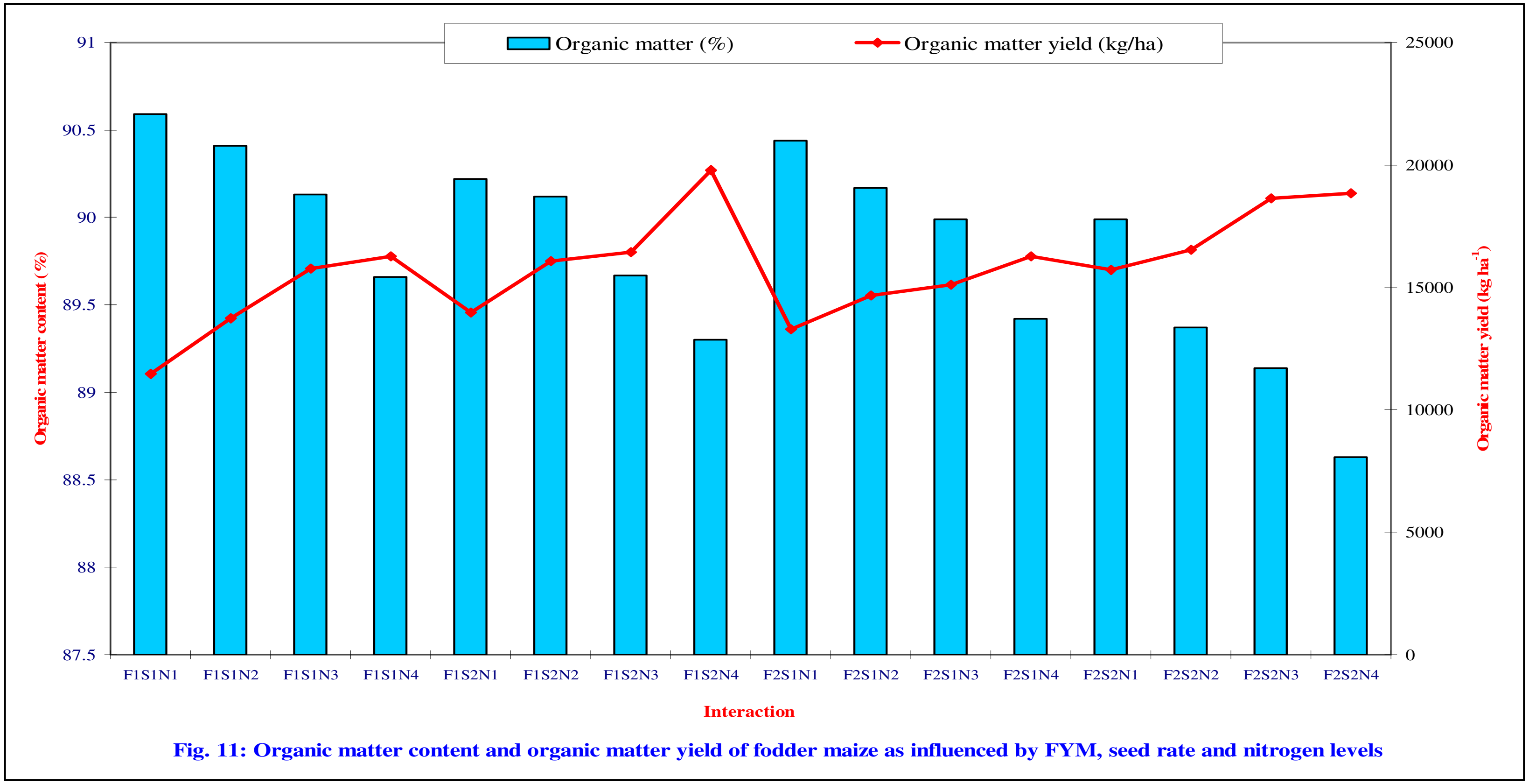

Fig. 11: Organic matter content and organic matter yield of fodder maize as influenced by FYM, seed rate and nitrogen levels

Table 16. Available nitrogen and organic carbon content of soil a after harvest of fodder maize as influenced by FYM, seed rate and nitrogen levels

Treatment	Available nitrogen (kg/ha)	Organic carbon (%)
Farmyard manure (t/ha) (F)		
10 (F_1)	191 b	0.55 b
20 (F_2)	198 a	0.56 a
S.Em.±	0.15	0.001
Seed rate (kg/ha) (S)		
60 (S_1)	204 a	0.56 a
80 (S_2)	190 b	0.56 a
S.Em.±	0.153	0.001
Nitrogen levels (kg/ha) (N)		
100 (N_1)	187 d	0.55 b
150 (N_2)	194 c	0.56 a
200 (N_3)	201 b	0.55 b
250 (N_4)	208 a	0.56 a
S.Em.±	0.30	0.002
Interaction (F x S x N)		
$F_1S_1N_1$	209 c	0.53 ef
$F_1S_1N_2$	217 b	0.55 cd
$F_1S_1N_3$	223 ab	0.57 ab
$F_1S_1N_4$	227 a	0.56 bc
$F_1S_2N_1$	189 gh	0.56 bc
$F_1S_2N_2$	196 d-f	0.54 de
$F_1S_2N_3$	202 d	0.52 f
$F_1S_2N_4$	209 c	0.55 cd
$F_2S_1N_1$	181 ij	0.56 bc
$F_2S_1N_2$	186 hi	0.55 cd
$F_2S_1N_3$	194 fg	0.55 cd
$F_2S_1N_4$	201 de	0.56 bc
$F_2S_2N_1$	171 j	0.54 de
$F_2S_2N_2$	179 j	0.58 a
$F_2S_2N_3$	185 h-j	0.57 ab
$F_2S_2N_4$	195 e-g	0.57 ab
S.Em.±	1.22	0.01

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

Table 17. Gross returns, net returns and benefit cost ratio (B:C) of fodder maize (African Tall) as influenced by FYM, Seed rate and Nitrogen levels

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C Ratio
Interaction (FxSxN)				
$F_1S_1N_1$	16397	37710 fg	21320 ef	2.30 b
$F_1S_1N_2$	17102	39480 f	22390 d-f	2.31 b
$F_1S_1N_3$	17807	41770 ef	23970 c-f	2.35 b
$F_1S_1N_4$	18512	43910 c-f	25410 b-e	2.37 b
$F_1S_2N_1$	16997	44710 c-f	27720 a-d	2.63 a
$F_1S_2N_2$	17702	47160 a-d	29460 a-c	2.67 a
$F_1S_2N_3$	18402	49160 a-c	30760 ab	2.67 a
$F_1S_2N_4$	19112	50400 ab	31300 a	2.68 a
$F_2S_1N_1$	21397	40600 ef	19210 f	1.90 d
$F_2S_1N_2$	22102	43400 d-f	21310 ef	1.96 cd
$F_2S_1N_3$	22807	45520 b-e	22720 d-f	2.00 cd
$F_2S_1N_4$	23512	47810 a-d	24310 c-f	2.03 cd
$F_2S_2N_1$	21997	47860 a-d	25870 b-e	2.21 bc
$F_2S_2N_2$	22702	48490 a-d	25790 b-e	2.14 b-d
$F_2S_2N_3$	23407	50330 ab	26930 a-d	2.15 b-d
$F_2S_2N_4$	24112	52430 a	28330 a-c	2.18 bc
S.Em.±		948.21	948.63	0.05

Means having same lower case letter/s in a column do not differ significantly by DMRT (P = 0.05)

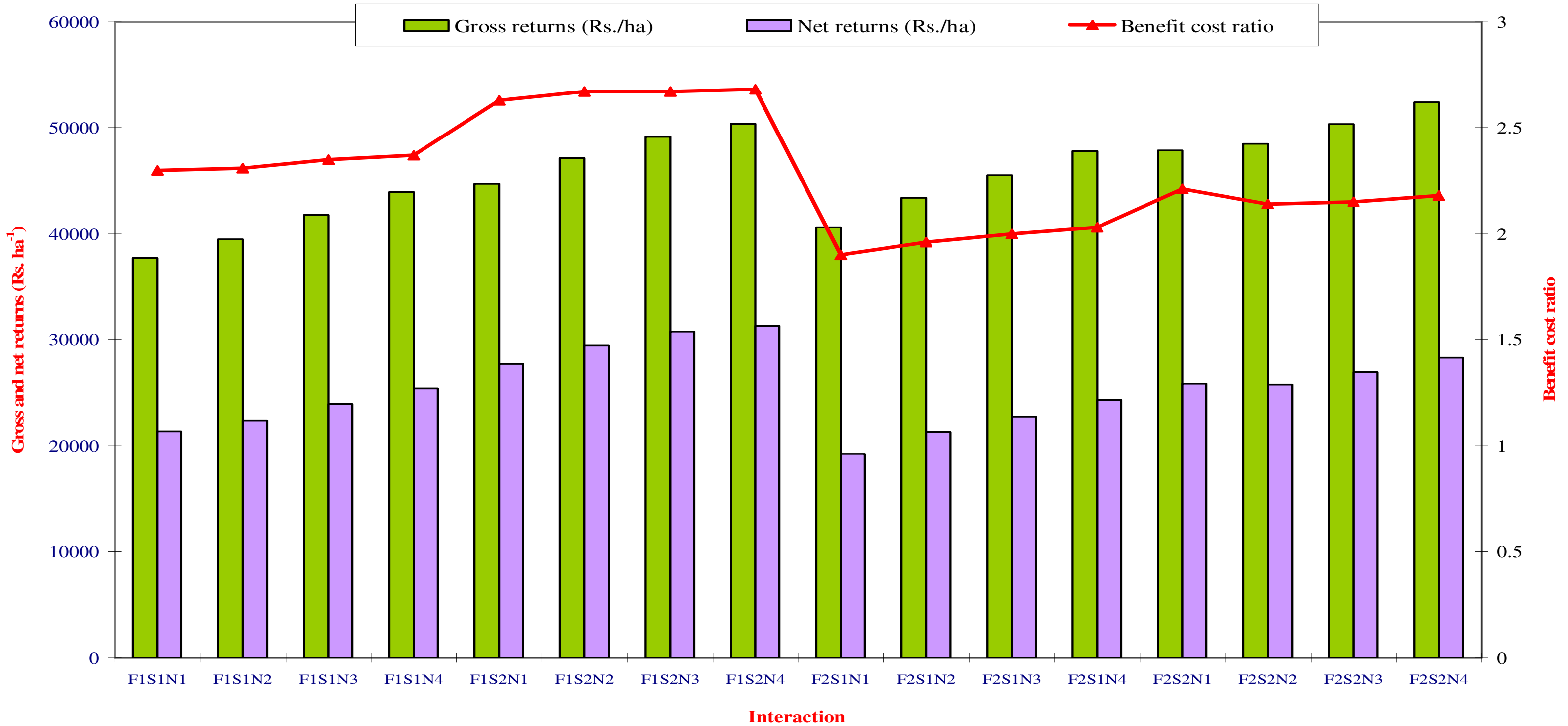

Fig. 12: Gross returns, net returns and benefit cost ratio (B:C) of fodder maize (African Tall)) as influenced by FYM, Seed rate and nitrogen levels

Fig. 12: Gross returns, net returns and benefit cost ratio (B:C) of fodder maize (African Tall)) as influenced by FYM, Seed rate and nitrogen levels

Application of 250 kg N ha^{-1} recorded significantly higher organic carbon content (0.56%) over 100 kg N ha^{-1} and 200 kg N ha^{-1} and was on par with 150 kg N ha^{-1} (0.56%)

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher organic carbon content (0.58%) over rest of the treatment combinations except $F_2S_2N_3$ (0.57%) and $F_2S_2N_4$ (0.57%) with which it was on par.

4.4 Economics

4.4.1 Gross returns (Rs. ha^{-1}) (cf. Table 17 and Fig. 12)

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher gross returns (Rs. 52430 ha^{-1}) over rest of the treatment combinations except $F_2S_2N_3$ (Rs. 50300 ha^{-1}), $F_2S_2N_2$ (Rs. 48490 ha^{-1}), $F_2S_2N_1$ (Rs. 47860 ha^{-1}), $F_2S_1N_4$ (Rs. 47810 ha^{-1}), $F_1S_2N_4$ (Rs. 50400 ha^{-1}), $F_1S_2N_3$ (Rs. 49160 ha^{-1}) and $F_1S_2N_2$ (Rs. 47160 ha^{-1}) with which it was on par.

4.4.2 Net returns (Rs. ha^{-1}) (cf. Table 17 and Fig. 12)

A treatment combination of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher net returns (Rs. 31300 ha^{-1}) over rest of the treatment combinations except $F_1S_2N_3$ (Rs. 30760 ha^{-1}), $F_1S_2N_2$ (Rs. 29460 ha^{-1}), $F_1S_2N_1$ (Rs. 27720 ha^{-1}), $F_2S_2N_4$ (Rs. 28330 ha^{-1}) and $F_2S_2N_3$ (Rs. 26930 ha^{-1}) with which it was on par.

4.4.3 B:C Ratio (cf. Table 17 and Fig. 12)

The treatment combinations of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha (2.68), FYM 20 t with 60 kg seed rate at 200 kg nitrogen per ha (2.67), FYM 20 t with 60 kg seed rate at 150 kg nitrogen per ha (2.67) and FYM 20 t with 60 kg seed rate at 100 kg nitrogen per ha (2.63) recorded on par B:C ratio and were significantly higher over rest of the treatment combinations.

5. DISCUSSION

The results obtained from the field experiment conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka, during 2010-11 to study the response of fodder maize and cowpea mixed cropping to FYM, seed rate and nitrogen levels are discussed in this chapter, with cause and effect relationship.

5.1 Weather conditions and crop performance

Crop growth is mainly dependent on environmental factors and weather fluctuations which greatly influence growth and development of crop. The meteorological data revealed that during the experimental year 2010-11, the rainfall received was 1007.7 mm (Table 2). This was 232.4 mm higher than average rainfall of past 60 years. The rainfall during the cropping period was 409 mm from June 19^{th} to September 19^{th} 2010. The rainfall was adequate and well distributed for better growth and development of crop.

The mean maximum temperature recorded during experimentation was in the range from 28.8^{o} C (June-2010) to 35.2^{o}C (March -2011), while minimum temperature ranged from 21.8^{o} C (June-2010) to 18.6^{o}C (September-2010). Both maximum and minimum temperature were favourable for normal growth and development of fodder maize and the temperature did not deviate much from the average of past 60 years.

5.2 Effect of farm yard manure

5.2.1 Effect of farmyard manure on growth, yield and quality of fodder maize

Application of farm yard manure @ 20 t ha^{-1} recorded significantly higher green forage and dry matter yield compared to 10 t ha^{-1}. There was an increased green fodder yield and dry fodder yield with the application of 20 t ha^{-1} to the tune of 6 per cent and 4.95 per cent respectively over 10 t ha^{-1}. The higher fodder yield at 20 t ha^{-1} is mainly attributed to higher values of growth components like plant height, number of leaves per plant and stem girth. Plant height at 20 t ha^{-1} at harvest was 291.4 cm compared to 272.4 cm at 10 t ha^{-1}. Likewise, number of leaves per plant was 12.33 and 11.95 at 20 t ha^{-1} and 10 t ha^{-1} of farmyard manure respectively. These results are in conformity with the findings of Oad *et al*. (2004).

Farm yard manure is an important organic source contributing for improvement of physical and chemical condition, resulting in enhanced crop growth and yield at higher levels compared to 10 t ha^{-1} respectively.

Similar favourable effects of farm yard manure and other organics on growth and forage yield were reported by Puri and Tiwana. (2008), Nanjundappa *et al*. (2002) and Amanuallah *et al*. (2007)

Application of farmyard manure @ 20 t ha^{-1} recorded significantly higher leaf : stem ratio, palatability, crude protein content and yield over 10 t ha^{-1}. The crude protein yield at 20 t ha^{-1} increased to an extent of 6.3 % over 10 t ha^{-1}. Whereas leaf: stem ratio and palatability at 20 t ha^{-1} were (0.91) and (99.36) per cent respectively over 10 t ha^{-1} (0.89 and 98.93 % respectively).

The higher crude protein yield at 20 t ha^{-1} farmyard manure is mainly attributed to higher dry matter yield of maize fodder compared to 10 t ha^{-1}. The results are in conformity with the findings of Patel *et al*. (2007) and Naidenov *et al*. (1991).

5.3 Effect of seed rate on growth, yield and quality of fodder maize

Seed rate is one of the most important factor which determines the yield and quality of fodder crops. Especially in fodder maize closer row spacing with higher seed rate results in more absorption of solar radiation and higher forage yield. As the seed rate increases, the amount of total nutrient uptake from soil also increases due to higher accumulation of biomass. Use of higher seed rates results in high population density.

A seed rate of 80 kg ha^{-1} recorded significantly higher green forage (69.88 t ha^{-1}) and dry matter yield (18.99 t ha^{-1}) compared to 60 kg ha^{-1}. There was increased green fodder yield and dry matter yield to the tune of 15.02 per cent and 17.36 per cent respectively over 60 kg ha^{-1}. The higher green forage yield at 80 kg ha^{-1} was mainly attributed to higher values of plant height and number of plants per m row.

Plant height at 80 kg seeds ha^{-1} at harvest was 296.3 cm compared to 267 cm at 60 kg ha^{-1}. Likewise number of plants per m row was 12.6 at 80 kg ha^{-1} compared to 9.9 at 60 kg ha^{-1}. Whereas, higher number of leaves and maximum stem girth were recorded at all the stages of growth at 60 kg seeds ha^{-1}. This is due to less number of internodes with more length because of higher population density at 80 kg ha^{-1} compared to 60 kg ha^{-1}.

Higher seed rate leads to closer intra row spacing and higher population density which results in more competition within plants for sunlight and nutrients due to which plants attain more height and ultimately higher biomass accumulation compared to 60 kg seeds ha^{-1}.

Similar favourable effects of higher seed rate on growth and forage yield are reported by Channakeshava *et al.* (1995) and Ayub *et al*. (2003)

Application of 80 kg seeds ha^{-1} recorded significantly higher palatability and crude protein yield over 60 kg ha^{-1}. The palatability at 80 kg ha^{-1} was 99.74 per cent compared to 60 kg ha^{-1}. Whereas, the crude protein yield at 80 kg ha^{-1} increased to an extent of 21.87 per cent over 60 kg ha^{-1}

The higher crude protein yield at 80 kg ha^{-1} seed rate is mainly attributed to higher dry matter yield ha^{-1} of fodder maize. The results are in conformity with the findings of Joshi *et al*. (2007) and Nehra *et al*. (1981).

5.4 Effect of nitrogen levels on growth, yield and quality of fodder maize

Nitrogen is a key nutrient in manipulating plant growth. Most of the farmers use large quantities of N fertilizers in an attempt to meet the needs of their crops. However, a thorough understanding of N nutrition can be useful in optimizing both the concentration and form of N best suited for the plant species, stage of growth, time of year and production objectives. When N is deficient in plants restricted growth of tops and roots and especially lateral shoots may occur. Plants also become spindly with a general chlorosis of entire plant to a light green and then yellowing of older leaves. This condition may proceed toward younger leaves. Application of higher dose of nitrogenous fertilizers increases the succulence in maize fodder which is highly preferred by milch animals. Therefore, it becomes necessary to determine the optimum dose, which fully meets the requirement of crop and ensure maximum returns.

Application of 250 kg N ha^{-1} recorded significantly higher green fodder yield (69.78 t ha^{-1}) over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1} (66.71 t ha^{-1}). Similarly 250 kg N ha^{-1} recorded significantly higher dry matter yield (19.94 t ha^{-1}) over rest of the treatments. There was increased green fodder yield at 250 kg N ha^{-1} to the tune of 14.33 per cent over 100 kg N ha^{-1} and 9.44 per cent over 150 kg N ha^{-1}. Whereas dry matter yield increased to the tune of 32.22 per cent over 100 kg N ha^{-1} and 17.64 per cent over 150 kg N ha^{-1} respectively. The higher green fodder and dry matter yield of maize fodder is mainly attributed to higher values of growth components like plant height, number of leaves per plant and stem girth. These results are in conformity with the findings of Sudeshkumar and Sharma (2002), Bhilare *et al*. (2002) and Dudhat *et al*. (2004)

Higher plant height at 250 kg N ha^{-1} at harvest recorded 290.7 cm which was higher over 100 kg and 150 kg N ha^{-1} and was on par with 200 kg N ha $^{-1}$ (284.9 cm). Likewise application of 250 kg N ha^{-1} recorded significantly higher number of leaves per plant and stem girth at harvest (12.83 and 9.51 cm) over 100 kg N ha^{-1} and 150 kg N ha^{-1} and was on par with 200 kg N ha^{-1}. These results are in conformity with the findings of Pathan *et al.* (2007) and Kaushalya Gupta *et al*. (2008)

Nitrogen is the key nutrient responsible for better growth and development of crop. It enhances the growth, yield and yield attributing characters resulting in higher forage yield at higher doses compared to 100 kg N ha^{-1}.

Nitrogen is the main constituent of protein and therefore becomes an essential element in improving the quality of fodder by increasing crude protein, leaf: stem ratio and palatability

Application of 250 kg N ha^{-1} recorded significantly higher leaf: stem ratio (0.97) over 100 kg N ha^{-1} and was on par with that of 200 kg ha^{-1}. Likewise, application of 250 kg N ha^{-1} recorded significantly higher palatability and crude protein yield (99.54 per cent and 1767 kg ha^{-1} respectively), compared to other nitrogen levels. The crude protein yield at 250 kg ha^{-1} increased to an extent of 48.03 per cent over 100 kg N ha^{-1} and 26.95 per cent over 150 kg N ha^{-1}.

The higher crude protein yield at 250 kg N ha^{-1} is attributed mainly to higher dry matter yield of fodder maize compared to 100 kg N ha^{-1}. The results are in conformity with the findings of Mohamed *et al*. (2010) and Karamundi *et al*. (1998).

5.5 Interaction effect on growth, yield and quality of fodder maize

In case of interaction effects more than a single factor is responsible for enhanced growth and development of a crop through combined and synergistic effect. Farmyard manure besides improving soil health results in increased nutrient use efficiency through higher productivity. Higher seed rate in forages like maize makes use of available nutrients efficiently through increased population density which taps higher solar radiation. Nitrogen coupled with higher seed rate can enhance the productivity to a greater level.

A treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher green forage (74.90 t ha^{-1}) and dry matter yield (22.17 t ha^{-1}) over $F_1S_1N_1$ (53.87 t ha^{-1} and 12.67 t ha^{-1}) and $F_1S_1N_2$ (56.40 t ha^{-1} and 15.20 t ha^{-1}) and was on par with that of $F_2S_2N_3$ (71.90 t ha^{-1} and 20.90 t ha^{-1} respectively). There was increased green forage yield and dry matter yield with $F_2S_2N_4$ to the tune of 39.03 and 67.87 per cent over $F_1S_1N_1$ and 32.80 per cent and 39.93 per cent over $F_1S_1N_2$ respectively. The higher forage yield of maize with treatment combination of $F_2S_2N_4$ is mainly attributed to higher values of growth components like plant height, number of leaves per plant and stem girth. The interaction effect of FYM, seed rate and nitrogen level is presented in Plate 2.

A treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher plant height at 30 DAS and at harvest (52.07 cm and 323.8 cm respectively) over $F_1S_1N_1$ (42.53 cm and 256.20 cm) and $F_1S_1N_2$ (44.60 cm and 259.67 cm) and was on par with that of $F_2S_2N_3$ (51.10 cm and 315.07 cm respectively). At 60 DAS, $F_2S_2N_4$ recorded significantly higher plant height (271.8 cm) over $F_1S_1N_1$ (233.7 cm) and $F_1S_1N_2$ (236.9 cm) respectively. A treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher number of leaves per plant at 30 and 60 DAS and at harvest (7.60, 10.47 and 13.70 respectively) over $F_1S_1N_1$ (6.70, 9.47 and 11.40) and $F_1S_1N_2$ (6.80, 9.70 and 12) and was on par with $F_2S_1N_3$ (7.53, 9.67 and 13.40). Likewise treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher stem girth at 30 DAS and at harvest (6.63 and 9.90 cm) over $F_1S_1N_1$ (6.07 cm and 9.20 cm) and $F_1S_1N_2$ (6.23 cm and 9.30 cm) and was on par with $F_2S_1N_3$ (6.47 cm and 9.70 cm) respectively. At 60 DAS, treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher stem girth 7.50 cm over $F_1S_1N_1$ and $F_1S_1N_2$ and was on par with $F_1S_1N_4$. The results are in conformity with the findings of Nanjundappa *et al*. (2002).

Combination of farmyard manure @ 20 t ha^{-1} with seed rate at 80 kg ha^{-1} and 250 kg nitrogen proved best interaction over rest of the treatment combinations for enhanced growth and yield of fodder maize.

Similar favourable effect of farmyard manure, nitrogen and seed rate on growth and forage yield of maize fodder were also reported by Girija Devi (2002) and Nanda *et al*. (2002).

Treatment combination of FYM 20 t with 60 kg seed rate at 250 kg nitrogen per ha recorded significantly higher leaf: stem ratio 1.10 over $F_1S_1N_1$ (0.88) and $F_1S_1N_2$ (0.89) and was on par with $F_2S_1N_3$ (0.95) respectively. Treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher palatability 100 per cent over $F_1S_1N_1$ (97.47 per cent) and was on par with $F_2S_2N_3$ (99.93 per cent).

Plate 2: Effect of FYM, Seed rate and nitrogen levels on fodder maize

Likewise, the treatment combination of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher crude protein yield (1999 kg ha^{-1}) over $F_1S_1N_1$ (956 kg ha^{-1}) and was on par with $F_2S_2N_4$ (1901 kg ha^{-1}). The crude protein yield at $F_1S_2N_4$ increased to the tune of 98.77 per cent over $F_1S_1N_1$ and 61.13 per cent over $F_1S_1N_2$

The higher crude protein yield recorded with treatment combination of $F_2S_2N_4$ is mainly attributed to higher protein content and dry matter of maize fodder compared to $F_1S_1N_1$ and $F_1S_1N_2$. These results are in conformity with the findings of Patel *et al.* (2007) and Ather Nadeem (2009).

The total ash content and total ash yield which was an indication of total minerals were significantly higher with FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha compared to other treatment combinations.

5.6 Economics

The treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher gross return (52430 Rs. ha^{-1}) over $F_1S_1N_1$ and $F_1S_1N_2$ (Rs. 37710 and 39480 ha^{-1}) and was on par with $F_2S_2N_3$ (Rs. 50330 ha^{-1}). There was increased gross return at $F_2S_2N_4$ to the tune of 39.03 and 32.80 per cent over $F_1S_1N_1$ and $F_1S_1N_2$ respectively. The higher gross returns at $F_2S_2N_4$ was attributed to higher green forage yield as a result of higher level of FYM, seed rate and N levels. Similarly FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher net returns (Rs. 31300 ha^{-1}) over $F_1S_1N_1$ and $F_1S_1N_2$ (Rs. 21320 and 22390 ha^{-1} respectively) and was on par with $F_1S_2N_3$ (Rs.30760 ha^{-1}). There was an increased net return at $F_1S_2N_4$ to the tune of 46.81 and 39.79 per cent over $F_1S_1N_1$ and $F_1S_1N_2$ respectively. Treatment combinations of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha recorded on par B:C ratio (2.68) with that of FYM 10 t with 80 kg seed rate at 100 kg nitrogen per ha, FYM 10 t with 80 kg seed rate at 150 kg nitrogen per ha and FYM 10 t with 80 kg seed rate at 200 kg nitrogen per ha (2.63, 2.67 and 2.67) compared to $F_1S_1N_1$ and $F_1S_1N_2$ (2.30 and 2.31 respectively). Higher net returns and B:C ratio at $F_1S_2N_4$ over $F_2S_2N_4$ was attributed to reduced cost of cultivation at $F_1S_2N_4$ due to lower cost of FYM at 10 t ha^{-1}. The results are in conformity with the findings of Sing *et al.* (2005) and Pushpendra Sing (2005)

Practical utility

The treatment combination of FYM 20 t with 80 kg seed rate at 250 kg nitrogen per ha recorded significantly higher green fodder yield (74.90 t ha^{-1}), dry matter yield (22.17 t ha^{-1}) over rest of the treatment combinations.

The treatment combination of FYM 10 t with 80 kg seed rate at 250 kg nitrogen per ha realized maximum net returns (Rs. 31300 ha^{-1}) and B:C ratio (2.68) over rest of the treatment combinations.

Future line of work

- Long term effects of farmyard manure on yield and quality of fodder maize + cowpea needs to be studied.
- Application of higher doses of nitrogen over and above 250 kg and seed rate over 80 kg ha^{-1} on fodder maize + cowpea needs to be evaluated.

6. SUMMARY AND CONCLUSION

A field experiment was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad in Northern Transition Zone of Karnataka on clayey soil to study the "Response of fodder maize and cowpea mixed cropping to FYM, seed rate and nitrogen levels" during 2010. The experiment was laid out in Randomized Complete Block Design with factorial concept with 16 treatment combinations consisting of two levels of farm yard manure (10 t and 20 t ha^{-1}), two levels of seed rate (60 kg and 80 kg ha^{-1}) and four nitrogen levels (100, 150, 200 and 250 kg N ha^{-1}). The results of the experiment are summarized in this chapter.

Effect of FYM on growth, yield and quality of fodder maize

Application of FYM @ 20 t ha^{-1} recorded significantly higher green fodder yield (67.22 t ha^{-1}) and dry matter yield (18.01t ha^{-1}) compared to 10 t ha^{-1}.

Application of FYM @ 20 t ha^{-1} recorded significantly higher plant height, number of leaves per plant and stem girth compared to 10 t ha^{-1} at all the stages of growth which has favorable effect on green and dry matter yield of fodder maize. But application of FYM @ 20 t ha^{-1} recorded on par number of plants per m row length with that of 10 t ha^{-1}.

Application of FYM @ 20 t ha^{-1} recorded significantly higher crude protein content (8.40 %), crude protein yield (1519 kg ha^{-1}), crude fibre yield (5492 kg ha^{-1}), total ash content (10.36 %), total ash yield (1876 kg ha^{-1}), ether extract (2.24 %), ether extract yield (405 kg ha^{-1}), nitrogen free extract (48.20 %), nitrogen free extract yield (4819 kg ha^{-1}), organic matter yield (16135 kg ha^{-1}), leaf:stem ratio (0.91) and palatability (99.36 %) compared to 10 t ha^{-1}. Whereas, organic matter content (90.01 %), total carbohydrate content (79.62 %), total carbohydrate yield (7962 kg ha^{-1}) and crude fibre content (32.05 %) were decreased significantly with the application of FYM @ 20 t ha^{-1} compared to 10 t ha^{-1}.

Effect of seed rate on growth, yield and quality of fodder maize

Application of 80 kg seeds ha^{-1} recorded significantly higher green fodder yield (69.88 t ha^{-1}) and dry matter yield (18.99 t ha^{-1}) compared to 60 kg ha^{-1}. Application of 80 kg seeds ha^{-1} recorded significantly higher plant height, number of leaves per plant and number of plants per m row at all the stages of growth compared to 60 kg ha^{-1}. Whereas, stem girth decreased due to increased seed rate. Application of 80 kg seeds ha^{-1} recorded significantly higher crude protein yield (1619 kg ha^{-1}), crude fibre yield (5690 kg ha^{-1}), total ash content (10.44 %),total ash yield (1993 kg ha^{-1}), ether extract (2.22 %), ether extract yield (423 kg ha^{-1}), nitrogen free extract (48.60 %), nitrogen free extract yield (4859 kg ha^{-1}) and organic matter yield (17002 kg ha^{-1}) over 60 kg ha^{-1} while crude protein content was on par (8.17%) with that of 60 kg ha^{-1}. Whereas, crude fibre content (32.61 %), total carbohydrate content (79.78 %), total carbohydrate yield (7977 kg ha^{-1}), organic matter content (90.10 %) were significantly higher with 60 kg ha^{-1} over 80 kg ha^{-1}.

Effect of nitrogen levels on growth, yield and quality of fodder maize

Application of 250 kg N recorded significantly higher green fodder (69.78 t ha^{-1}) and dry matter yield (19.94 t ha^{-1}) compared to lower levels, except 200 kg N ha^{-1}.

Increase in each level of nitrogen from 100 to 250 kg N ha^{-1} significantly increased all the growth parameters like plant height, number of leaves, stem girth, number of plants per m row length and leaf: stem ratio over rest of the treatments at all the stages of growth.

Application of 250 kg N ha^{-1} recorded significantly higher crude protein (8.85%), crude protein yield (1767 kg ha^{-1}), crude fibre yield (5623 kg ha^{-1}), total ash content (10.75 %), total ash yield (2147 kg ha^{-1}), ether extract (2.26 %), ether extract yield (451 kg ha^{-1}), nitrogen free extract (49.81 %), nitrogen free extract yield (4980 kg ha^{-1}), total carbohydrate content (78.14 %), total carbohydrate yield (7814 kg ha^{-1}), organic matter yield (17793 kg ha^{-1}) compared to rest of the treatments. Whereas, crude fibre content (34.19%), total carbohydrate content (80.33 %), total carbohydrate yield (8032 kg ha^{-1}) and organic matter content (90.31 %) were significantly higher with the application of 100 kg N ha^{-1}.

Interaction effect on growth, yield, quality and economics of fodder maize

Higher green fodder yield (74.90 t ha^{-1}) and dry matter yield (22.17 t ha^{-1}) were recorded with $F_2S_2N_4$ (FYM @ 20 t ha^{-1} + 80 kg seeds ha^{-1} + 250 kg N ha^{-1}), followed by $F_1S_2N_4$ (FYM @ 10 t ha^{-1} + 80 kg seeds ha^{-1} + 250 kg N ha^{-1}) (73.17 t ha^{-1}) and $F_2S_2N_3$ (FYM @ 20 t ha^{-1} + 80 kg seeds ha^{-1} + 200 kg N ha^{-1}) (20.90 t ha^{-1}).

The same treatment combination $F_2S_2N_4$ (FYM @ 20 t ha^{-1} + 80 kg seeds ha^{-1} + 250 kg N ha^{-1}) recorded higher growth parameters like, plant height, number of leaves per plant, stem girth, number of plants per m row length and leaf: stem ratio, resulting in higher green fodder and dry matter yield of fodder maize.

FYM @ 20 t ha^{-1} + 80 kg seeds ha^{-1} + 250 kg N ha^{-1}) also recorded higher total ash content (11.37 %), total ash yield (2417 kg ha^{-1}), ether extract (2.38 %), ether extract yield (506 kg ha^{-1}), nitrogen free extract (51.10 %), nitrogen free extract yield (5110 kg ha^{-1}) and organic matter yield (19795 kg ha^{-1}). Whereas crude fibre content (35.60 %), total carbohydrate content (81.02 %) total carbohydrate yield (8101 kg ha^{-1}) and organic matter content (90.59 %) were higher with $F_1S_1N_1$ (FYM @ 10 t ha^{-1} + 60 kg seeds ha^{-1} + 100 kg N ha^{-1}) treatment combination. Similarly the treatment combination of $F_1S_2N_4$ recorded significantly higher crude protein content (9.02 %), crude protein yield (1999 kg ha^{-1}) and crude fibre yield (6089 kg ha^{-1}).

Treatment combination of $F_2S_2N_4$ (FYM @ 20 t ha^{-1} + 80 kg seeds ha^{-1} + 250 kg N ha^{-1}) recorded significantly higher gross returns (Rs. 52,430. ha^{-1}) while $F_1S_2N_4$ (FYM @ 10 t ha^{-1} + 80 kg seeds ha^{-1} + 250 kg N ha^{-1}) recorded significantly higher net returns (Rs. 31,300 ha^{-1}) and B:C ratio (2.68).

REFERENCES

Agarwal, S. B., Shukla, V. K., Sisodia, H. P. S., Ranji Tomar and Arti Shrivastava, 2005, Effect of inoculation and nitrogen levels on growth, yield and quality of fodder sorghum [*Sorghum bicolor* (L.) Monech] verities, *Forage Res.,* **31** (2) : 106-108.

Amanullah, M. M; Alagesan, A; Pazhanivelan, S Vaiyapuri, K, 2007, Effect of organic application on maize fodder production. Sindh Agric. Univ., Tandojam, Pakistan.

Ammaji, P. and Suryanarayana, K., 2002, Influence of different levels of nitrogen on yield and nutritive parameters of cereal fodder varieties. *J. Res.,* ANGRAU. **30**(4) : 11-16

Anonymous, 1999, *Economic Survey 1998-99*, Government of Karnataka, Bangalore.

Anonymous, 2009, Post harvest management of crop residues/grasses/fodder crops and their value addition for sustaining livestock. *Winter School*, Indian Grassland and Fodder Research Institute, Jhansi. pp. 13-23.

Anshu Chotiya and Singh, P., 2005, Effect of Graded levels of nitrogen and phosohorus on sorghum fodder production, *Forage Res.,* **31** (3) : 218-219.

AOAC, 2001, *Association of Official Analytical Chemists,* International Official Methods of Analysis, 17th Ed. Horwitz W. (ed.) : AOAC Inc., Arlington, USA.

Asare, E. O. and Adjepong Vamoah, A. A. K., 1989, Effect of plant population density and fertilizer nitrogen on performance and quality of fodder maize for silage, Association Francaise Pourla Production Fourrager, pp. 871-872.

Ather Nadeem, M., Zafar Iqbal, Muhammad Ayub, Khuram Mubeen and Ibrahim M., 2009, Effect of nitrogen application on forage yield and quality of maize sown alone and in mixture with legumes. *Pak. J. Life Soc. Sci.,* **7**(2) : 161-167.

Ayub, Asif Tanveer, Safdar Ali, and Mateer Nadeem, 2002, Effect of different nitrogen levels and seed rates on growth, yield and quality of sorghum (*Sorghum bicolor*) fodder. *Indian J. Agric. Sci.,* **72** (11) : 648-650.

Ayub, M; Ahmad, R; Nadeem, M. A; Ahmad, B; Khan, R. M. A., (2003), Effect of different levels of nitrogen and seed rates on growth, yield and quality of maize fodder, *Pakistan J. Agric. Sci.,* **40**(3/4) : 140-143.

Balasaraf, M. D. and Mothite, A. V., 1994, Effects of FYM, PMC and pyrite on nutrient uptake and yield of crops in black calcareous soil. *J. Maharashtra Agric. Univ.,* **19** (1) : 125-126.

Barsukov, S. S., 1991, Effect of organic and mineral fertilizer on yield of maize according to cereal technology. *Agrokhimniya*, **12** : 43-48.

Bhagade, H. S., Rajemahadik, V. A. and Akhave, S. R., 2008, Integrated nutrient management studies on growth, quality and yield of fodder maize in Konkan region. *Int. J. Agric. Sci*., **4**(2) : 513-515.

Bhilare, R. L, Aher, V, R., Hiray, A. G. and Gethe, R. M., 2002, A response of multicut sorghum to nitrogen application. *J. Maharashtra Agric. Univ.,* **27** (3) : 339-340.

Brinton, W. F. and Seekins, M. D., 1994, Evaluation of farm plot conditions and effects of fish scap compost on yield and mineral composition of field grown maize. *Compost Sci. Util.* **2** (1) : 10-16.

Channakeshava, B. C., Ramachandrappa, B. K and Janarjuna, S (1995), Response of fodder maize cv. South African Tall to seed rate, *Curr. Res.,* University of Agricultural Sciences, Bangalore, **24**(9) : 166-167.

Dastane, N.G., 1967, *A Practical Manual for Water Use Research in Agriculture*. Navabharat Prakashan, Pune, p. 120.

Dineshkumar, M., 1986, Production potential of maize for fodder purpose in paddy fallows. *M. Sc. (Agri.) Thesis,* Univ. Agric. Sci., Bangalore, Karnataka (India).

Dudhat, M. S., Savalia, M. G. and Ramdevputra, M. V., 2004, Response of fodder maize to nitrogen and phosphorous levels. *Forage Res.,* **30** (1) : 34-35.

Eltelib, H. A., Hamad, M. A., Ali, E. E., 2006, The effect of nitrogen and phosphorous fertilization on growth, yield and quality of forage maize. *J. Agron.,* **5**(3) : 515-518.

Gangaiah, B., 2004, Effect of animal urine application on growth and yield of fodder maize. *Indian J. Agri. Sci*., **74**(12) : 678-679.

Gomez, K. A. and Gomez, A. A., 1984, *Statistical Procedures for Agricultural Research,* An international Rice Research Institute Book, Wiley- Inter Science Publication, New York, USA, 680.

Grija Devi, L., 2002, Forage yield of maize (*Zea mays* L.) as influenced by nitrogen levels and biofertilizers, *Forage Res.,* **27**(4) : 263-266.

Jackson, M. L., 1973, *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd., New Delhi, p. 498.

Jadhao, S. L; Padghan, S. K; Ingole, P. G; Malvi, S. D; Gore, N. B., (1995), Effect of nitrogen levels on growth, yield and quality of two fodder maize varieties, *PKV Res. J.,* **19**(2) : 188-189.

Joshi, Y. P. and Kuldeep Kumar, 2007, Effect of nitrogen levels and seed rate on growth, yield and quality of fodder maize variety African Tall. *Forage Res.,* **33**(3) : 171-173.

Karamundi, B. P; Vasuki, N; Satyanarayana, T., 1998, Effect of nitrogen and copper on quality of fodder maize. *J. Trop. Agric.,* **36**(1/2) : 62-64.

Kaushalya Gupta, Rana, D. S. and Sheoran, R. S., 2008, Response of nitrogen and phosphorus levels on forage yield and quality of sorghum [*Sorghum bicolor* (L.) Monech]. *Forage Res.,* **34** (3) : 156-159.

Mohamed El-Murtada Hassan Amin, 2010, Effect of different nitrogen sources on growth, yield and quality of fodder maize (*Zea mays* L.). *J. Saudi Soc. Agric. Sci.,* **10** : 17–23.

Muhr, G.R., Dalla, N.P., Shankarambramaney, H., Leley, V.R. and Danahue, R.L., 1965, *Soil Testing in India*, USAID New Delhi, pp. 39-41.

Naidenov, A. S., Soldatenko, A. G. and Terekhova, S. S., 1991, Effect of long term application of organic and mineral fertilizers on soil fertility, yield and quality of agricultural crops in a rotation. *Agrokhimiya*, **5** : 49-55.

Nanda, S. S., Bishoyi, B. S. and Alim, M. A., 2002, Management of nitrogen with or without organic manures in forage maize-wheat sequence. *Environ. and Ecol.,* **20**(3) : 656-660.

Nanda, S. S; Swain, K. C; Mohanty, A. K; Alim, M. A., (1995), Effect of nitrogen and biofertilizers in fodder maize under rainfed upland conditions of Orissa, *Curr. Agric. Res.,* **8**(Supplement) : 45-47.

Nanjundappa, G; Shivaraj, B; Sridhara, S; Janarjuna, S., (2002), Effect of organic and inorganic sources of nutrients alone and in combination on the growth and yield of fodder maize, *Mysore J. Agric. Sci.,* **34**(3) : 247-250.

Nehra, D. S., Tomer, P. S., Sing, S. M. and Pahuja, S. S., 1981, Effect of nitrogen levels, weed control and seed rates on yield and quality of fodder maize. *Forage Res.,* **14**(7) : 195-200.

Niu RuiMing; Lu AiZhi; Guo BaoAi; Yan GuiLong; Yue Chun Wang, (2005), Effect of nitrogen top dressing on yield and quality of green maize in northwest arid land in Hebei province. *J. Maize Sci.,* **13**(2) : 116-118.

Oad, F. C., Buriro, U. A. and Agha, S K., 2004, Effect of organic and inorganic fertilizer on the yield and quality of fodder maize, (*Zea mays*), *Research on Crops,* **8**(1) : 99-103.

Ogunlela, V. B., Amoruwa, G. M. and Ologunde, 1988, Growth, yield components and micronutrients nutrition of field grown maize as affected by nitrogen fertilization and plant density. *Fertilizer Res.,* **17**(2) : 189-196.

Patel, A. S., Sadhu, A. C., Patel, M. R. and Patel, P. C., 2007, Effect of Zinc, FYM and fertility levels on yield and quality of forage maize (*Zea mays*). *Forage Res.,* **32**(4) **:** 209-212.

Patil, S. L. and Shelavantar, M. N., 2000, Yield and yield components of *rabi* sorghum (*Sorghum bicolor*) as influenced by *in-situ* moisture conservation practices and integrated nutrient management in *vertisols* of semi-arid tropics of India.

Phatan, S. H., Bhilare, R. L., Nawale, K. B. and Jadhav, V. T., 2007, Response of multicut oat varieties to nitrogen levels. *Forage Res.,* **32**(4) : 269-270.

Piper, C. S., 1996, *Soil and Plant Analysis*, Academic Press, New York, pp. 236.

Prasanna kumar, A. S. Halepyati, B. K. Desai and Pujari, B. T., 2008, Effect of integrated nutrient management on economics of maize cultivation*. Karnataka J. Agric. Sci.,* **20**(4) : 831-832.

Puri, K. P. and Tiwana, U. S., 2008, Effect of organic and inorganic sources of nitrogen in forage maize *Forage Res.,* **34**(1) : 62-63.

Purushotham, S., Siddaraju, R. and Gopinathan, N., 2002, Response of fodder maize to different levels of N, P, K, and sulphur under irrigation during late *rabi*. *Curr. Res.,* UAS Bangalore, **31**(5/6) : 87-88

Pushpendra Singh and Sumeriya, H. K., 2005, Response of forage sorghum cultivars to different nitrogen levels under Udaipur conditions in Rajasthan. *Forage Res.,* **31**(1) : 51-54.

Rafiqul Islam, Syed Mohammad Ehsanur Rahman and Mukhlesur Rahman, 2010, The effects of biogas slurry on the production and quality of maize fodder. *Turk J Agric For.,* **34** : 91-99.

Ram, M.S. and Bhagwan Singh, 2003, Growth, yield and quality of forage sorghum as affected by intercrop , harvesting time and niyrogen fertilization under rainfed conditions. *Indian J. Dryland Agric. Res. Dev.,* **18** (2) : 167-172.

Reddy, B. G. and Reddy, M. G., 1999, Effect of integrated nutrient management on soil available micronutrients in maize-soybean cropping system. *J. Res.*, ANGRAU, **27**(3) : 24-28.

Schans, D. A, and Vander Dijk Van, (1994), Nitrogen use in maize during the juvenile stage. *Publikatie Proestation vooe de Akkerbouw en de Groenteteelt in de Vollegrond, Lelystad,* **73-A** : 164-168.

Sharma, J. P., 1983, Economy in fertilizer use through organic manures in growing maize. *Indian J. Agron*, **28**(2) : 154-155.

Singh, M. M., Maurya, M. L., Singh, S. P. and Mishra, C. H., 2005, Effect of nitrogen level and biofertilizer inoculation on productivity of forage sorghum (*Sorghum bicolor*). *Forage Res.,* **75**(3) : 167-168.

Sood, B. R., Gurudev Sing, and Naveen Kumar, 1994, Evaluation of maize fodder varieties for forage yield under different levels of nitrogen. *Forage Res.,* **20**(2&3) : 208-209.

Subbiah, B. V. and Asija, G. L., 1956, A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.,* **25** (8) : 259-260.

Sudesh Kumar and Sharma, B. L., 2002, Effect of FYM, nitrogen and *Azospirillum* inoculation on yield and quality of forage sorghum, *Forage Res.,* **28**(3) : 165-168.

Sunil Kumar, Rawat, C. R., Singh, K. and Melikania, N. P., 2004, Effect of Integrated nutrient management on growth, herbage productivity and economics of forage sorghum [*Sorghum bicolor* (L.) Monech]. *Forage Res.,* **30**(3) : 140-144.

Taneja, K. D., Gill, P. S. and Lodhi, G. P., 1984, Effect of dates of sowing, seed rate and nitrogen levels on green and dry matter yield of maize. *Forage Res.,* **10**(2) : 99-102.

Tiwana, U. S., Puri, K. P. and Sukhpreet Singh, 2003, Fodder yield and quality of multicut pearl millet (*Pennisetum glaucum*) as influenced by nitrogen and phosphorus under Punjab conditions, *Forage Res.,* **28**(4) : 190-193.

Tripathi, S. B. and Hazra, C. R., 2002, Forage productivity of winter maize under legume cover as influenced by nitrogen fertilization. *Forage Res.,* **28**(2) : 55-58.

Verma, S. S., Kumar, A. and Sing, V., 1999, Effect of nitrogen levels and row spacing on nitrogen content and uptake in fodder maize. *Forage Res.,* **25**(2&3) : 139-140.

Verma. S. S., Navneet Singh, Joshi, Y. P. and Vijay Deprari, 2005, Effect of nitrogen and zinc on growth characters, herbage yield, nutrient uptake and quality of fodder sorghum (*Sorghum bicolor*). *Forage Res.,* **50**(2) : 167-169.

Appendix I: Prices for inputs and output

Sl. No.	Item	Unit	Price (Rs.)*
A. Inputs			
1	Tractor charges	hr	250
2	Seeds	kg	100
a.	Fodder maize (African tall)	kg	30
b.	Cowpea (DFC-1)	kg	40
3	Manures and Fertilizers		
	FYM	t	500
	DAP	kg	10.2
	Urea	kg	5.2
	MOP	kg	6.0
4	Labour charges		
	Male (for 8 hr)	day	95
	Female (for 8 hr)	day	85
	Bullock pair with bullock man (8 hr)	day	300
B. Output			
1	Fodder maize	t	700

* - Source MARS, UAS, Dharwad, 2010-11

Appendix II: Treatment – wise details of cost of cultivation (Rs. ha^{-1})

Particulars	$F_1S_1N_1$	$F_1S_1N_2$	$F_1S_1N_3$	$F_1S_1N_4$	$F_1S_2N_1$	$F_1S_2N_2$	$F_1S_2N_3$	$F_1S_2N_4$	$F_2S_1N_1$	$F_2S_1N_2$	$F_2S_1N_3$	$F_2S_1N_4$	$F_2S_2N_1$	$F_2S_2N_2$	$F_2S_2N_3$	$F_2S_2N_4$
Land preparation																
Cultivator (tractor)	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
Harrowing	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
Sowing																
Cost of seeds	1800	1800	1800	1800	2400	2400	2400	2400	1800	1800	1800	1800	2400	2400	2400	2400
Cost of sowing	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Manures and fertilizers																
Cost of FYM	5000	5000	5000	5000	5000	5000	5000	5000	10000	10000	10000	10000	10000	10000	10000	10000
Cost of fertilizers	4092	4797	5502	6207	4692	5397	6102	6807	4092	4797	5502	6207	4692	5397	6102	6807
Application charges	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
Hand weeding	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850
Inter-cultivation	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Green fodder harvesting																
Labour charges	950	950	950	950	950	950	950	950	950	950	950	950	950	950	950	950
Total cost of cultivation	16397	17102	17807	18512	16997	17702	18402	19112	21397	22102	22807	23512	21997	22702	23402	24112

RESPONSE OF FODDER MAIZE AND COWPEA MIXED CROPPING TO FYM, SEED RATE AND NITROGEN LEVELS

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ABSTRACT

A field experiment was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad in Northern Transition Zone of Karnataka on black clay soil to study the response of fodder maize and cowpea mixed cropping to FYM, seed rate and nitrogen levels during *kharif* 2010. The experiment was laid out in randomized complete block design with 16 treatment combinations consisting two FYM levels (10 and 20 t ha^{-1}), two seed rates (60 and 80 kg ha^{-1}) and four levels of nitrogen (100, 150, 200 and 250 kg ha^{-1}) The crop was sown in 30 cm rows. The common recommended dose of 75 kg P_2O_5 and 25 kg K_2O per ha was applied. Nitrogen, FYM and seeds were applied as per the treatment. The crop was harvested at milky stage. Biometric observations were recorded at harvest. The forage quality parameters were analyzed on dry matter basis following the standard procedures.

The FYM at 20 t ha^{-1} recorded significantly higher total green forage and dry matter yield (67.22 and 18.01 t ha^{-1} respectively) compared to 10 t ha^{-1}. The seed rate of 80 kg ha^{-1} produced significantly higher green forage yield (69.88 t ha^{-1}) compared to 60 kg ha^{-1}. The nitrogen level of 250 kg ha^{-1} produced significantly higher green forage and dry matter yield (69.78 and 19.94 t ha^{-1}) compared to 100, 150 and 200 kg ha^{-1} nitrogen. Significantly higher total green forage yield (74.90 t ha^{-1}) and total dry matter yield (22.17 t ha^{-1}) were obtained at 20 t FYM ha^{-1} with 80 kg ha^{-1} seed rate and 250 kg N ha^{-1}. Whereas, maximum net returns (Rs. 31300 ha^{-1}) and benefit cost ratio (2.68) were obtained at FYM 10 t ha^{-1} with 80 kg seed rate ha^{-1} and 250 kg N ha^{-1}.