EFFECT OF ESTABLISHMENT METHOD AND NUTRIENT MANAGEMENT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF BABY CORN (*Zea mays* L.)

Thesis

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Pantnagar **(Abhishek Bahuguna)**
June, 2019 **Author**

CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF ESTABLISHMENT METHOD AND NUTRIENT MANAGEMENT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF BABY CORN (*Zea mays* L.)"** submitted in partial fulfilment of the requirements for the degree of **Masters of Science** with major in **Agronomy** of the College of Post-Graduate Studies, G.B. Pant University of Agriculture and Technology, Pantagar, is a record of *bona fide* research carried out by **Mr. Abhishek Bahuguna, Id. No. 44768**, under my supervision and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

Pantnagar
June, 2019

(Mahendra Singh Pal)
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CERTIFICATE

We, the undersigned, members of the Advisory committee of **Mr. Abhishek Bahuguna, Id. No. 44768**, a candidate for the degree of **Master of Science** with major in **Agronomy,** agree that the thesis entitled **"EFFECT OF ESTABLISHMENT METHOD AND NUTRIENT MANAGEMENT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF BABY CORN (*Zea mays* L.)"** may be submitted in partial fulfilment of the requirements for the degree.

(Mahendra Singh Pal)
Chairman
Advisory Committee

(Sobaran Singh)
Member

(D. K. Shukla)
Member

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LIST OF ABBREVIATIONS

%	:	Per cent
@	:	At the rate
^{O}C	:	Degree centigrade
&	:	And
a.i.	:	Active ingredient
Am	:	Ante Meridian
B:C	:	Benefit: cost
cm	:	Centimeter
CGR	:	Crop Growth Rate
C.D.	:	Critical Difference
DAS	:	Days After Sowing
d.f.	:	Degree of freedom
dSm^{-1}	:	Deci Simens per meter
Fig.	:	Figure
et al	:	Co-workers
E.C.	:	Electrical Conductivity
g	:	Gram
g/kg	:	Gram/ kilogram
ha	:	Hectare
K	:	Potassium
K_2O	:	Potassium oxide
Kg	:	Kilogram
kg/ha	:	Kilogram/hectare
LAI	:	Leaf Area Index

Maxi.	:	Maximum
Min.	:	Minimum
mm	:	Millimeter
M	:	Meter
mg	:	Milligram
N	:	Nitrogen
O.C.	:	Organic Carbon
P	:	Phosphorus
P_2O_5	:	Phosphorus pentaoxide
Pm	:	Post meridian
Q	:	Quintile
q/ha	:	Quintal per hectare
RDF	:	Recommended Dose of fertilizer
RGR	:	Relative growth rate
Rs.	:	Rupees
Rs./ha	:	Rupees/ hectare
R.H. Mini	:	Relative Humidity Minimum
R.H. Maxi	:	Relative Humidity Maximum
SEm±	:	Standard Error of mean
T	:	Temperature
Tab.	:	Table
Maxi. temp.	:	Maximum temperature
Min. temp.	:	Minimum temperature
VC	:	Vermicompost
RDN	:	Recommended dose of nitrogen

Introduction

CHAPTER 1 INTRODUCTION

Maize (Zea mays L.) is one of the most versatile cereal with wider adaptability growing in all seasons for food, feed, biofuel, fodder and other industrial uses **(Khawar and Farooq, 2007).** It belongs to Poaceae family with chromosome no. 2n= 20. It is originated from Mexico and grown from 60° N in Canada and Russia to 40° S latitude in Argentina, from below sea level to an altitude of > 4,000 m in the Peruvian Andes and in the regions with < 25 cm rainfall in semi-arid plains of Russia to regions of > 1,000 cm rainfall in north-east India **(Sharma and Das, 2002)**. Genetic studies reveal that teosinte (*Euchlaena maxicana* Schrad.) is the closest wild relative of maize. The origin of the word "maize" is believed to be from Taino people which means mahis, considered as "source of life". It is well distributed to different climatic regions starting from tropical to temperate regions. Globally, maize is cultivated on 190 mha area with production of 1076.18 Mt and productivity of 5.65 Mt/ha **(USDA, 2017-18)**. In India, maize occupies 9.22 mha area with production and productivity of 28.72 Mt and 3.12 Mt/ha, respectively **(USDA, 2017-18).** It is mainly cultivated in *Kharif* season as a rainfed crop, whereas in peninsular India and Bihar during *rabi* season. Broadly, maize can be divided into different groups like flint corn, dent corn, sweet corn, flour corn, popcorn, pod corn, waxy corn, baby corn, starch corn and oil corn. Every part of maize plant, its grain, cob, stalk, leaves, tassel can be used for food and non-food uses. Globally, out of total production, 61% is used for feed, 22% for industrial and only 17% for food purpose while in India 47% is used for poultry feed, 20% for direct consumption, 14% for cattle feed, 20% for starch production and 7% for food processing, brewery & other purposes **(IMA, KPMG Analysis, 2014).** Therefore, owing to its various uses and highest yield potential among all cereals, it is called as 'Queen of cereals'.

Baby corn is one of the highly valued vegetable which is gaining popularity throughout the world including India due to its higher nutritional value, market price and short duration. Baby corn is young finger like unfertilized cob with 1-3 cm emerged silk preferably harvested within 1-3 days after silk emergence, depending on the growing season. **Das *et al.* (2009)** reported that 100 g of baby corn contains 89.1% moisture, 0.2 g fat, 1.9 g protein, 8.2 mg carbohydrate, 0.06 g ash, 28 mg calcium, 86 mg phosphorus and 11 mg ascorbic acid. **Muthukumar *et al.* (2005)** reported that 10-12 cm long ears with

1-1.5 cm diameter, light yellow in colour with regular row arrangement are preferred for marketable quality of baby corn. It can be eaten as a raw salad, chutney, soup, mix vegetable, pickles, candy, murabba, soup, kheer, halwa etc.

Baby corn is low calorie vegetable, low in carbohydrate and fat, high in fiber content, nutrient rich and good source of vitamins and minerals. It has lower glycemic index than corn so it is good for sugar patients. It's a dual purpose crop which can be used for vegetable and fodder purpose and its short duration nature makes it suitable for fitting it in most of the cropping systems and crop diversification. Moreover, 2 crops of baby corn can be grown in same season due to its short duration (<60 days). Fodder obtained from baby corn is more nutritious than normal corn as green cobs are harvested which checks diversion of nutrients for grain filling. This vegetable is free from the residual effect of pesticides as the green cobs are enclosed inside the husk. Baby corn has great scope in domestic as well as in foreign market for export purpose. The cultivation practices of baby corn are almost similar to the normal corn except it requires higher plant population, higher nitrogen dose and harvesting within 1-3 days of silk emergence.

Thailand, Sri Lanka, Taiwan, China, Zimbabwe, Zambia and South Africa are the leading producer countries of baby corn, however, due to its higher consumption in Asia, U.K., U.S.A., Malaysia, Japan and Australia, they become major importers of baby corn **(Wailare, 2012)**. In India, baby corn cultivation is popular among the farmers of Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Karnataka and Andhra Pradesh **(Kheibari *et al.*, 2012).**

Productivity and profitability of any crop is affected by different factors including crop establishment method and proper nutrient management. Baby corn is a highly exhaustive C_4 plant with greater growth rate. Nutrient requirement of baby corn is higher than normal grain crop as it is planted at high density. Optimum dose of N: P_2O_5:K_2O i.e. 150-180:60-70:40-50 kg/ha has been reported in different parts of the country **(Saha and Mondol, 2006 and Singh *et al*., 2010).** Nitrogen is required in higher amount and its supply is required throughout the growing period. It plays important role in protein synthesis and plant metabolism. **Narang *et al.* (1989)** reported that maize responded up to 120 kg/ha in rainy and up to 180 kg/ha in winter season in soils of Punjab. Phosphorus is essential for energy storage and transfer and also required for ATP formation and root growth. Besides this it also makes an essential component of DNA, RNA, phospholipid, phosphoproteins and coenzymes. Thus phosphorus is very important for proper growth and development of reproductive parts. Unlike, N, P and other nutrient potassium does not form any biochemical component of plant system but exists freely in solution and bound to charges in tissue surface so its functions are related to water relations, osmoregulation and charge balance. Potassium is called as quality element because of its contribution to many of the characteristics such as size, shape, color and taste of the produce.

The chemical fertilizers are essential and costly input but important source of environment pollution and health hazards. Integrated nutrient management including organics can be viable option, so, organic manures such as vermicompost and farmyard manure are important components of integrated nutrient management. Integrated nutrient management (INM) aims to provide plant nutrient supply at an optimum dose along with maintenance of soil fertility for sustaining the desired productivity through adopting the all possible sources of nutrient like organic, inorganic and biological in integrated manner. Vermicompost is the product of composting process in which the earthworm species are used for the conversion of organic waste into the better end product. It contains water soluble nutrients and its application improves soil aeration, enriches soil with micro-organisms, improves water holding capacity, enhance germination, soil microbial population and enzymatic activities. When chemical fertilizers supplied with vermicompost it results in better yield and quality of the corn **(Kannan *et al.,* 2013).**

Planting methods play a vital role for better establishment of crop under a set of growing condition and affect the yield and quality of the produce. Flat bed sowing, ridge sowing and furrow sowing are different methods of planting crops. The success of *Kharif* crop planted on flat beds is restricted in high rainfall areas so, there is a need to find out the suitable planting method for reducing the harmful effects of temporary flooding and increasing water productivity. During heavy rains, excess water restricts plant growth and development as the crop is very sensitive to water stagnation. The risk of lodging is also more prominent in *Kharif* season as high moisture content along with high wind velocity is responsible for lodging. High temperature along with high humidity during *Kharif* months causes high evapotranspiration losses.

A planting method which provides safety to the crop from water logging, lodging and enhanced crop growth is very desirable, hence FIRBS, raised bed and ridge planting methods may be better options. Ridge sowing causes better grain yield, less lodging and better water productivity than flat–bed planting due to better conditions for root growth and nutrient uptake **(Bakht *et al.*, 2011)** with 20-30% water saving and higher water productivity. Sowing crop on ridges in rainy season provides good root aeration, better microclimate and furrows act like a drainage channel which protect crop from ill effects of water logging leading higher crop productivity. In winter season, these furrows harvest water and fulfill the water requirement of the crop. **Freeman *et al.* (2007)** reported that planting maize crop on raised beds and ridges led to good nutrient, water and weed management so, the sowing on ridges and bed planting provides a better option for achieving better crop stand, increased nutrient use efficiency and water productivity.

Manipulation in agronomic practices has greater role to boost the productivity of the crop. Response of chemical fertilizers has been explored widely across the globe but the research work on substituting chemical fertilizers with organics particularly vermicompost and their combinations is meager. Similarly, little work has been done on the proper establishment methods in *Kharif* season along with proper nutrient management strategy and needs attention of researcher to enhance input use efficiency, productivity and profitability of baby corn. Therefore, viewing above fact, the present study entitled **"EFFECT OF ESTABLISHMENT METHOD AND NUTRIENT MANAGEMENT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF BABY CORN (*Zea mays* L.)"** was carried out with the following objectives;

1. to study the effect of establishment method and nutrient management on growth, yield and quality of baby corn.
2. to assess the interaction effect between establishment method and nutrient management.
3. to find out the effect of establishment method and nutrient management on soil health.
4. to work out the economics of baby corn production in *Tarai* region of Uttarakhand.

Review of Literature

CHAPTER-2 REVIEW OF LITERATURE

Baby corn is growing popularly as a multipurpose crop. Efforts have been made on the different aspects across the globe to improve the productivity and quality of baby corn. In this chapter, attempts have been made to review the work done in India and abroad related to effect of establishment method and nutrient management on productivity, profitability, quality, growth parameter, nutrient uptake and economics of baby corn.

The literature collected have been divided under the following subheads;

1- Effect of establishment method and nutrient management on growth parameters.
2- Effect of establishment method and nutrient management on yield parameters.
3- Effect of establishment method and nutrient management on nutrient uptake and quality.
4- Effect of establishment method and nutrient management on economics.
5- Effect of establishment method and nutrient management on physico-chemical properties of soil and residual soil fertility.

2.1. Effect of establishment method

2.1.1. Growth parameters

2.1.1.1. Plant population, emergence and mortality percentage

Anjum *et al.* (2014) revealed that germination percentage and field emergence were enhanced with ridge sowing and it was found at par with the bed planting, however **Bakht *et al.* (2011)** found insignificant effect of planting methods on emergence percentage. **Singh (2005)** reported higher values of emergence percentage, plant height and stover yield in ridge planted spring maize as compared to flat planted. **Painyuli (2010)** reported higher plant population of sweet corn under ridge planting followed by flat + earthing and flat method, respectively.

2.1.1.2. Plant height and leaf area index (LAI)

Kaur (2013) conducted a field experiment at PAU, Punjab and found that bed planting of maize resulted in significantly higher values of LAI and plant height (30, 60 and 90 days after sowing) as compared to flat sowing but statistically at par with ridge planting. **Anjum *et al.* (2014)** reported that when the maize crop was grown on ridges it showed maximum leaf area index (LAI) than flat method of sowing. **Bakht *et al*. (2011)** found taller plants of maize under ridge planting than flat planting and it was also supported by **Balachew & Abera (2010). Balsaubramaniyan *et al*. (2001)** also supported the above finding with higher leaf area index (5.22) under ridge planting.

2.1.1.3. Dry matter and number of functional leaves

Singh and Vashist (2015) revealed that under ridge planted maize, all the growth parameters like no. of leaves per plant, plant height, LAI and dry matter accumulation were found significantly higher as compared to flat sowing. **Panwer *et al.* (2006)** studied the response of baby corn to nitrogen and land configuration in mid hills of Meghalaya, India and found that the number of functional leaves were highest under flat-bed planting followed by earthing up in baby corn. This fact was also supported by **Singh (2005)** and **Ramakrichenin *et al.* (2002).** However, **Brar (2013)** found that growth parameters, yield and quality of spring maize did not change significantly with respect to different planting method.

2.1.1.4 Growth rate and days to 50% silking

Days taken to 50% silking were found significantly minimum under ridge sown crop as compared to flat and trench method **(Kumar and Chawla, 2015). Tanveer *et al.* (2014)** conducted a field study at Faisalabad, Pakistan to evaluate growth of maize to different planting methods and found maximum net assimilation rate (6.27 g/m^2/day) and crop assimilation rate (17.39 g/m^2/day) under bed planting system and lowest under sowing with multiple crop planter. The lowest and the highest time taken by bed planted and flat sown maize with dibbler, respectively for days to 50% silking.

Anjum *et al.* (2014) revealed that planting method had significant effect on days taken to 50% tasseling. It was also found that ridge planted maize took less days to 50% tasseling as compared to flat planted crop. **Bakht *et al.* (2011)** concluded that maize crop planted under ridge took more time to 50% silking and differed significantly with other treatments. This finding was also supported by **Bakht *et al.* (2006).**

2.1.2. Yield attributes

Javed *et al.* (2018) revealed that all the yield components of spring maize were superior in case of ridge planting as compared to flat planting however it did not affect the N uptake significantly. **Gul *et al*. (2014)** at Sher-e-Kashmir University, Budgam reported higher cob length and diameter which might be due to higher leaf area index and plant height in ridge planted maize under fertile loose soil of Kashmir. **Painyuli *et al.* (2013)** at pantnagar conducted an experiment and found significantly higher shoot and root growth and more cob yield of sweet corn under ridge planting as compared to flat method followed by earthing and flat planted (without earthing).

Memon *et al*. (2007) reported higher number of cobs/plant, cob length and grain weight under ridge planting as compared to flat, furrow and bed planted maize. These findings were also supported by **Bakht *et al.* (2006). Thakur *et al.* (2003)** studied the effect of land treatments on productivity of rainfed maize varieties grown on Vertisols of Madhya Pradesh, India and found that flat planting with earthing up at 25 days after planting was superior to flat planting in terms of grain and straw yield**.**

2.1.3. Yield

Kumar and Chawla (2015) recorded higher grain yield under ridge and trench planted crop than flat sowing. **Kaur (2013)** evaluated different planting method of maize and found that yield attributing parameters, grain and stover yield under bed planting were statistically at par with ridge planted maize but significantly higher than flat planted and it was also supported by **Singh (2011).** A field study conducted at PAU, Ludhiana revealed that winter maize planted on one row per bed resulted in highest grain yield (55.82 q/ha) compared to flat sowing followed by earthing up (52.33 q/ha) **(Anonymous, 2004). Rasheed *et al.* (2003)** found that maize planted on ridges gave higher yield than flat planted maize due to improved soil physical condition and proper root growth which led to good nutrient use efficiency under ridge planting. **Ramakrichenin *et al.* (2002)** compared the five planting method viz. flat sowing, ridge method, compartmental bunding, broad beds and furrows in maize and found that ridge and furrow planting resulted in higher values of all growth and yield parameters which led to higher yield under ridge furrow sowing (34.6 q/ha) however in contrast maize sown on ridges resulted in significantly lower grain yield (14.5 q/ha) compared to flat sowing (15.5 q/ha) **(Jat *et al.*, 2005)**

2.1.4. Quality

Kumar and Narayan (2018) found that bed planting resulted in 14.17% higher yield and significantly higher protein, oil and starch content in sweet corn than furrow planting. **Painyuli (2010)** revealed that planting method did not affect TSS of sweet corn significantly however maximum TSS was found in case of ridge planting. The nutrient uptake and protein content in maize were found maximum under ridge planting **(Singh *et al.,* 2003). Rasheed *et al.* (2003)** concluded that the maize crop sown on ridges or in double row strips (70 cm spacing) resulted in significantly higher quality parameters like protein content, oil content and grain oil than crop sown on single rows (70 cm spacing) but statistically at par with each other.

2.1.5. Nutrient uptake

Verma *et al.* (2018) reported higher nutrient uptake, available N, P, K and S under bed planting but at par with ridge and furrow planting compared to flat sowing. **Kaur (2016)** reported that bed planted maize resulted in highest nitrogen uptake in grains (115.3 kg/ha) and stover (40.4 kg/ha) which was found statistically at par with ridge planting. These findings were supported by **Kaur (2013). Rahman *et al.* (2011)** compared three methods of sowing *viz.*, flat sowing, ridge sowing and strip planting at Pakistan and revealed that ridge sown maize with 75 cm space gave the higher fertilizer use efficiency, nutrient use efficiency and N uptake efficiency. **Rasheed *et al.* (2003)** supported these finding however, in contrast **Kashif *et al.* (2018)** found that planting method had no significant effect on nitrogen uptake.

2.1.6. Soil physico-chemical properties and residual soil fertility

Raised bed planting led to higher soil respiration rate which had positive effect on soil microbial population **(Govaerts *et al.,* 2007). Deshmukh (2006)** revealed that ridge planting resulted in significantly higher values of organic carbon content but found insignificant in case of N, P_2O_5 and K_2O. **Hemmat and Eskandari (2004)** reported that raised bed planting had higher bacterial count than flat planting due to proper aeration.

2.1.7. Economics

Nagdeote *et al*. (2016) conducted a field experiment on Vertisols at PDKV, Akola, Maharashtra and reported higher net and gross return and highest B:C ratio of sweet corn planted in ridge and furrow. **Manea (2014)** reported significantly higher net income and benefit cost ratio of baby corn on ridge planting than flat planting. Similarly, **Khan *et al.* (2012)** reported maximum gross income (129438 Rs/ha), net income (954863 Rs/ha) and B:C ratio of 1.74 under ridge planted maize crop followed by bed and flat planting.

2.2. Effect of nutrient management

2.2.1. Growth parameters

2.2.1.1. Plant population, emergence and mortality percentage

Joshi and Chilwal (2018) reported that INM practice did not affect field emergence and plant population significantly in baby corn, however maximum value of emergence percentage was found under the application of 75% NPK + biofertilizer, 100% NPK + biofertilizer and 50% NPK. However, **Khan *et al.* (2008)** reported higher field emergence and lower mortality at higher nitrogen dose.

2.2.1.2. Plant height and leaf area index (LAI)

Nagavani and Subbian (2014) found tallest plant with 100% RDF from urea and remained at par with 50% RDF from urea + 50% RDF from poultry manure, while LAI was highest with 50% RDF from urea + 50% RDF from poultry manure which was found at par with 50% RDF from urea + 50% RDF from vermicompost. INM practice with chemical fertilizers and vermicompost produced the tallest plants **(Kannan *et al.*, 2013). Mahdi *et al*. (2012)** concluded that plant height increased significantly with successive increase in nitrogen dose from 0 to 120 kg/ha. **Singh *et al.* (2010)** recorded higher plant height of baby corn with the application of 125% RDF. **Dadarwal *et al*. (2009)** reported that treatment receiving 75% NPK + 2.25 t/ha vermicompost recorded maximum plant height. **Verma *et al*. (2006)** reported that growth parameters increased significantly up to harvest with integrated nutrient management. **Haq (2006)** revealed that integrated application of mineral fertilizer along with farm yard manure significantly increased plant height, leaf number and LAI of maize crop. **Verma *et al*. (2006)** reported that the application of 150% of RDF resulted in maximum plant height, leaf area index and dry matter (g per plant) could be achieved. **Thavaprakash *et al*. (2005)** reported that integrated use of 50% NPK along with poultry manure and bio-fertilizers recorded higher LAI and tallest plants in baby corn. **Jayaprakash *et al.* (2004)** evaluated effect of organics on growth parameters and found that treatment receiving vermicompost @ 2t/ha had significantly higher LAI than treatment with no organics but at par with the application of FYM @ 10 t/ha.

2.2.1.3. Dry matter and number of functional leaves

Ravi *et al*. (2012) reported that integrated application of well rotten farm yard manure along with chemical fertilizer significantly increased dry matter. Significantly taller plants, number of leaves per plant, dry matter and relative growth rate were found with the application of 120 kg N from urea + 30 kg N from poultry manure which were comparable with 90 kg N from urea + 30 kg N from poultry manure + azotobacter **(Kumar *et al*., 2008). Prasanna *et al.* (2007)** found significantly higher dry matter production (314.67 g/plant) with the application of vermicompost. **Bindhani *et al*. (2007)** revealed that higher dry matter production and taller plants could be produced by application of 120 kg N /ha**. Haq (2006**) reported that application of mineral fertilizers in combination with FYM caused increased growth parameters of maize like leaf area index, plant height and no. of functional leaves.

100% RDF from chemical fertilizer along with vermicompost @ 5 t/ha was the best combination for better dry matter production **(Lourduraj, 2006).** Higher dry matter production was found with the application of vermicompost @ 2.5 t/ha **(Aggarwal *et al.,* 2003). Karki *et al.* (2005)** confirmed highest values of plant height and dry matter accumulation with the application of recommended dose of fertilizers which was found statistically similar with 120 kg N + 5 kg Zn /ha + 10 t/ha FYM. **Jayaprakash *et al.* (2004)** found highest dry matter at vegetative stages and at harvest with the application of vermicompost than FYM.

2.2.1.4. Growth rate and days to 50% silking

The application of 75% recommended dose of fertilizer along with vermicompost, phosphate solubilizing bacteria and azotobactor resulted in highest CGR (19.80) followed by 100% RDF along with phosphate solubilizing bacteria and azotobactor (17.4) **(Chetri, 2016). Priya *et al*. (2004)** found that the application of 100 % NPK + 10 t/ha FYM resulted in highest crop growth rate (21.74, 25.42 g/m^2/day) and relative growth rate (0.067, 0.037 g/g/day) between 30-45 and 45-60 days after sowing. INM practice significantly affected the crop growth rate during the whole crop period till harvest. **Karforfma *et al.* (2012)** revealed that crop growth rate of fodder maize was higher at application of 50% recommended dose of chemical fertilizer along with 50% RDN through farm yard manure.

Bakele et al. (2018) concluded that integrated application of vermicompost, mineral P and lime significantly took less time to 50 % tesseling. **Gunjal *et al.* (2017)** reported that treatment receiving 125% N + 25% N through vermicompost significantly took more days to silking and tasseling than other treatment but found at par with 125 % recommended dose of nitrogen + 25% FYM, while lowest value was recorded at 75% recommended dose of nitrogen + 25% nitrogen through FYM. These finding are in close agreement with **Kolari *et al.* (2014).**

2.2.2. Yield parameters

Kashif *et al.* (2018) conducted a field trial at Pakistan to evaluate effect of planting method and nitrogen sources and their interaction on yield, yield uptake and nitrogen uptake in maize. They revealed that ridge planting method along with the application of poultry manure is the suitable practice for cultivation of *spring* maize. Interaction between planting method and nitrogen source was found significant with respect to ear length and number of grain/ear. Integrated nutrient management with vermicompost and chemical fertilizers increased yield parameters **(Kannan *et al*., 2013). Ali *et al.* (2012a)** concluded that application of compost with nitrogenous fertilizer had insignificant effect on numbers of ear per plant. However, in contrast **Shah *et al.* (2009)** reported maximum numbers of cobs per plant at combined application of urea and FYM followed by sole application of urea.

Khan *et al.* (2008) reported that application of organic manures, green manures, FYM etc. caused significant increase in growth and yield parameters like cob length and diameters. 50% RDF from chemical fertilizer along with 50% N from FYM had significant effect on yield parameters of maize **(Panwar, 2008). Nanjappa *et al.* (2001)** reported that application of 50% or 75% RDF along with 2.7 t/ha of vermicompost led to higher productivity of maize than sole application of vermicompost or inorganic fertilizer**.** Yield attributing characters of maize like cob length, girth and cob weight were found significantly higher at application of 100% RDF + PSB + Azotobactor and statistically at par with 70% RDF + Azotobactor + PSB.

2.2.3. Yield

Verma *et al.* (2018) found that application of 75% recommended dose of nitrogen (RDN) through fertilizer + 25% RDN through fortified vermicompost gave significantly higher yield of maize which remained at par with 75% RDN through chemical fertilizer + 25% RDN through vermicompost. **Kumar (2014)** revealed that treatment receiving vermicompost @ 5t/ha + 75% RDF showed significantly highest productivity of maize (4402 kg/ha). **Keerthi *et al*. (2013)** conducted an experiment on sandy loam soils of Agriculture College Farm, Naira in *Rabi* season and found that integrated nutrient management with vermicompost and vermiwash caused highest green cob yield of sweet corn. **Aravinth *et al.* (2011)** conducted an experiment in *Kharif* season on baby corn and reported that the application of RDF + Vermicompost @ 5 t/ha produced maximum number of cobs/plant (2.60), cob length (23.18) and highest baby corn yield (7195 kg/ha) than the sole application of chemical fertilizer. **Ali *et al.* (2011)** reported that combined application of both organic and inorganic fertilizers gave higher grain yield and higher 1000 seed weight.

Das *et al.* (2010) reported that 100% NPK (50:60:30 kg/ha) + azolla compost (2.5 t/ha) application resulted in highest number of cobs/m^2 and cob length in maize. **Ashoka *et al.* (2008)** reported that the application of RDF +25 kg Zinc Sulphate + Ferus Sulphate + Vermicompost @ 35 kg/ha produced highest values of yield attributing characters and grain yield. **Prasanna *et al.* (2007)** reported significantly higher grain yield at application of vermicompost and yield realization from application of sorghum residue was found at par with FYM, poultry manure and green manure incorporation. There was 2.35 % and 35.25 % increase in grain yield due to application of FYM and vermicompost respectively over control. **Meena *et al.* (2007)** concluded that application of vermicompost 1.5 t/ ha resulted in significantly highest straw (6031 kg ha^{-1}) yields which was remained at par with the application of 1.0 t/ha vermicompost.

Mahala and Shaktawar (2004) found that there was significantly higher grain and stover yield at application of 10 to 20 t FYM /ha and had positive effect on green cob yield as compared to control. Above findings were found in close resemblance with the findings of **Verma *et al.* (2003). Nanjappa *et al.* (2001)** concluded that integrated use of 50% recommended dose of fertilizers + 12 t/ha was statistically at par with 75 % RDF with fertilizer + 2.7 t/ha vermicompost in terms of productivity of maize but found significantly higher than sole use of organic or chemical fertilizer.

2.2.4. Quality

Jinjala *et al.* (2016) reported that integrated nutrient management did not affect protein content significantly but significantly higher vitamin C, total sugar and numerically higher crude protein content were found in treatment receiving 100% nitrogen from vermicompost and lowest values of quality parameters were found in case of 100% nitrogen from chemical fertilizers. These finding were supported by

Ramesh *et al.* (2008). The application of vermicompost @ 1.5 t/ha recorded significantly higher crude protein content than lower doses of vermicompost and control. **Keerthi *et al.* (2013)** revealed that treatment receiving N: P: K (180:75:60 kg/ha) + vermiwash produced significantly higher value of protein content in maize than treatment N: P: K (180:75:60 kg/ha) + 30 kg N/ha with vermicompost. **Balai *et al.* (2011)** observed that integrated application of soil test RDF + farm yard manure @ 10 t/ha resulted in highest values of carbohydrate (69.98%) and protein (10.13%) in maize**.** **Dalvi *et al.* (2009)** concluded that quality parameters of sweet corn like total sugar, reducing and non-reducing sugars increased by the application of organic, inorganic alone or by their combination in the ratio of 50% each. Highest vitamin C content (100.6 mg/100 g) was realized by the application of 50% RDF +3 t/ha vermicompost or 7.5 t/ha FYM.

2.2.5. Nutrient uptake

Kumar *et al.* (2018) found higher uptake of N, P, K and Zn with the application of 75% NPK+ farm yard manure @ 6 t/ha+ $ZnSO_4$ @ 25 kg/ha. **Wailare and Kesarwani (2017)** reported that combination of 50% RDF with 5 t/ha FYM or poultry manure not only caused increased productivity but also resulted in improved physio-chemical properties of soil. Similar results were also confirmed by **Wailare (2012).** Maximum nutrient concentration (N, P, K= 1.47%, 0.34%, 0.81% respectively) and nutrient uptake (N, P, K= 75.29 kg/ha, 17.39 kg/ha and 41.77 kg/ha, respectively) was found under the application of 75% recommended dose of nitrogenous fertilizer along with 25% N from vermicompost and 100% P_2O_5 **(Reddy *et al.*, 2016). Choudhary and Kumar (2013)** found that nitrogen, phosphorus and potassium uptake was higher by the application of vermicompost followed by poultry manure and it was found least in case of control. **Kannan *et al.* (2013)** confirmed integrated use of vermicompost and recommended dose of NPK through fertilizer resulted in maximum organic carbon build up in soil**.** Non- chemical sources of fertilizers provide a viable alternate to chemical fertilizers and they have significant effect on nutrient build up in soil (**Ebrahimpour *et al.*, 2011**). **Mahesh *et al.* (2010)** reported that treatment containing integration of RDF along with FYM 10t/ha recorded higher nutrient uptake (N, P, K) followed by 75% RDN through fertilizer and 25% N through poultry manure. **Rao *et al.* (2010)** suggested that integrated nutrient management in rainfed maize caused sustainability and maintenance of soil health. **Singh *et al.* (2010)** confirmed that $N:P_2O_5:K_2O$ (180 : 38.7 : 74.7 kg) + 50% N through FYM caused significant increase in soil nutrient status after harvesting of baby corn. **Vajantha *et al.* (2010)** noticed that integrated use of inorganic fertilizers along with organics significantly increased the available nutrients in soil. The highest values of N, P, K and Sulphur were realized by the application of poultry manure.

Dadarwal *et al.* (2009) reported that NPK status of soil improved after the continuous application of farm yard manure. Significantly higher nutrient uptake (N: P: K= 185.86 kg/ha:64.13 kg/ha:180.24 kg/ha) was seen in the treatment receiving 125% RDF + Poultry manure **(Shashidhar *et al.*, 2009). Tolessa *et al.* (2001)** revealed that application of nitrogen @ 150 kg/ha along with enriched FYM resulted in enhanced uptake of N, P and K (233 kg/ha, 73.3 kg/ha and 238 kg/ha, respectively). **Shivay and Singh (2000)** at Pantnagar noticed that uptake of nitrogen in maize stover and grain was significantly increased with the increment in the dose of nitrogen from 0 to 120 kg/ha. **Rekhi *et al.* (2000**) reported that long term supply of 150% NPK through chemical fertilizer or their integration with organics increased availability of phosphorus.

2.2.6. Economics

Yadav *et al*. (2016) observed that significantly higher maize equivalent yield, net return and B:C ratio at application of vermicompost 5 t/ha in combination with 75% RDF. **Shah and Kumar (2014)** reported maximum mean net returns (Rs 87297.5/ha) and B:C ratio (1.6) under 50% NPK + FYM @ 15t/ha. **Nagavani and Subbian (2014)** concluded that the application of 100% recommended dose of fertilizer through chemical fertilizer resulted in highest gross (54498 Rs/ha), net return (36478 Rs/ha) and B:C ratio (2.94) followed by application of 50% RDF with 50% nitrogen through poultry manure. Nitrogen dose of 120 kg/ha was found statistically at par with 150 kg/ha dose in terms of net return, profitability and net return per rupee **(Singh *et al*., 2012).**

Das *et al.* (2009) found highest yield (51.48 q/ha), highest B:C ratio and maximum net profit of Rs 144,900/ha at application of 120 kg N/ha. Treatment with the application 100% NPK + FYM + green manuring of sunhemp resulted in highest gross (Rs 37.701/ha) and net return (Rs 24,989/ha**) (Shashidhar *et al*., 2009).** Treatment 75

% NPK + 2.25 t/ha vermicompost + bio fertilizer generated significantly higher net return, benefit cost ratio in baby corn **(Dadarwal *et al*., 2009). Kumar *et al.* (2005)** revealed that treatment 100% NPK through chemical fertilizer yielded maximum net return per hectare (Rs 11443) and statistically at par with the treatment 100% NPK + 10 t/ha FYM.

2.2.7. Soil physico-chemical properties and residual soil fertility

Khan *et al.* (2017) reported that there was no significant change in the values of pH. and EC under the INM practice. **Khan *et al.* (2017)** reported highest population of bacteria (68.6 $\times 10^5$ CFU/g) and fungi (71.3 $\times 10^5$ CFU/g) under the treatment 75% NPK through inorganic fertilizer + 25% farm yard manure however lowest population of microbes was observed in unfertilized control.

Maximum reduction was in pH. and EC was seen under the farm yard manure applied plots **(Kumpawat, 2004). Yogananda *et al.* (2004)** reported significantly deduction in the pH. and EC values by the application of N+P+K + compost. **Bhattacharya *et al.* (2004)** concluded that values oxidizable and non –oxidizable organic carbon increased in the FYM treated plot. **Badole and More (2001)** concluded on the basis of 2-year experimental data that the soil microbial population like fungi, bacteria were increased under the integrated nutrient management. **Srikanth *et al.* (2000)** noticed decline in the pH. value by the application of FYM (7.08) and vermicompost (7.04) over control (7.24) and clarified the acidifying effect of organic acids generated during the process of decomposition.

Organic carbon of the sandy clay loam soil increased from 0.61 to 0.92 by the application of nitrogen @ 50 kg/ha + farm yard manure @ 5 t/ha **(Babu and Reddy, 2000)**. while **Manna and Ganguly (2001)** revealed that combined application of inorganic along with organic manures had favorable effect on the soil microbial population.

Materials & Methods

CHAPTER-3 MATERIALS AND METHOD

The present investigation entitled **"EFFECT OF ESTABLISHMENT METHOD AND NUTRIENT MANAGEMENT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF BABY CORN (*Zea mays* L.)"** was undertaken during *Kharif* 2018. The details of edaphic and climatic condition during the experimental period along with material used and procedure adopted have been presented in this chapter.

3.1. Experimental site

The field experiment was conducted during *Kharif* season-2018 at the Instructional Dairy Farm, Nagla, G.B. Pant University of Agriculture & Technology, Pantnagar (U.S. Nagar), Uttarakhand (Plate.1). The experimental site is located in the *Tarai* region of Shivalik range of Himalayas in between latitude of 29° N to longitude of 79.3° E and located at an altitude of 243.84 meter above the mean sea level.

3.2. Climate and Weather

The area falls in the subtropical region and characterized with cold winters and hot dry summers. During summer, maximum temperature reaches to 40°C while in winters minimum temperature occasionally touches 0°C. An average annual rainfall of the area is 1300 mm and major portion of rainfall occurs between 3rd weeks of June to end of September. The mean relative humidity remains almost 80-90% from mid-June to end of Feb and then it decreases to 50% by the 1st week of May and remains the same till mid-June.

The meteorological data of the area during the crop season were recorded at meteorological observatory of Norman E. Borlaug Crop Research Centre of the university and some important meteorological observations [maximum and minimum temperatures (^{o}C), relative humidity (%), rainfall (mm), number of rainy days, sunshine (hrs.), wind velocity (km/hr.) and pan evaporation (mm) are presented in the figure 1 and Appendix I. During the experimental period, weekly mean maximum and minimum temperature was ranged between 37.2 ^{o}C & 24.1 ^{o}C with relative humidity humidity from 76.4 to 93.6%. An average 93 mm rainfall was received during the crop season.

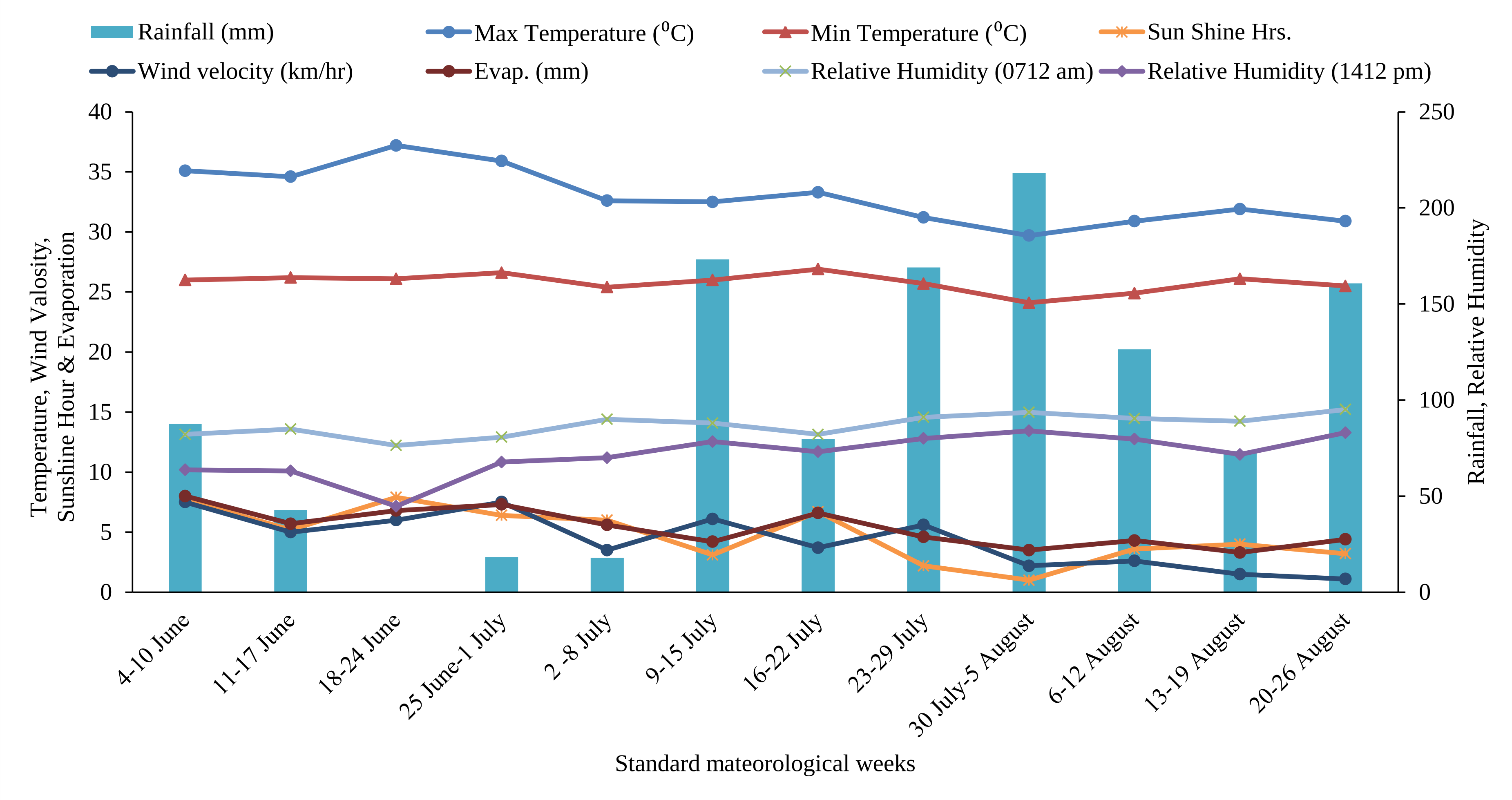


Fig 1. Weather prevailing during the crop growth period (*Kharif* -2018)

Plate 1. General view of experimental site

3.3. Soil characteristics

The soil of the *Tarai* region comes under Mollisols order and developed from calcareous medium to moderately coarse textured parent material under the forest vegetation. Soil is slightly silty clay loam in texture with granular structure. The representative soil sample was taken from the experimental area (0-15 cm depth) prior to sowing, shade dried, grinded and then passed through 2 mm sieve and analyzed for different parameters. The chemical parameters of the soil are mentioned in the Table.3.1.

Table. 3.1. Chemical properties of the experimental area

S. No.	Properties	Value	Method adopted
1	Soil pH (1:2 soil water suspension)	7.16	Glass electrode pH meter (Jackson, 1973)
2	EC (dS/m at 25ºC)	0.190	Conductivity meter (Bower and Wilcox, 1965)
3	Organic carbon (%)	0.74	Wet oxidation method (Jackson, 1973)
4	Available Nitrogen (kg/ha)	282.51	Alkaline Permagnate method (Subbiah & Asija, 1956)
5	Available Phosphorus (kg/ha)	28.16	Olsen's method (Olsen *et al.*, 1954)
6	Available Potassium (kg/ha)	235.00	Neutral normal 1 NH_4OH method (Hanway and Heidal, 1952)

3.4. Experimental details

The experiment composed of establishment method in main plot and nutrient management option in subplot, was executed in a split plot design (SPD) with 3 replications. There were 3 establishment methods and 5 nutrient management options. The details of the treatments are given below;

Factor A: Establishment method (Main plot): 03

Symbol	**Treatment**
E_1	Flat method
E_2	Flat + Earthing (flat followed by earthing)
E_3	Ridge method

Factor B: Nutrient management (Sub plot) :05

Symbol	Treatment
N_1	Control
N_2	100% VC @ 10t/ha
N_3	100% RDF
N_4	50% RDF + 50% VC
N_5	75% RDF + 25% VC

The dose of vermicompost (VC) is decided on nitrogen equivalent basis which also fulfilled the required amount phosphorus and potassium.

3.5. Treatment combinations and symbols

The details of the treatment combinations and their respective symbols are given below;

T_1	E_1N_1	Flat method- control
T_2	E_1N_2	Flat method- 100% VC @ 10t/ha
T_3	E_1N_3	Flat method- 100% RDF
T_4	E_1N_4	Flat method- 50% RDF + 50% VC
T_5	E_1N_5	Flat method- 75% RDF + 25% VC
T_6	E_2N_1	Flat method + Earthing- control
T_7	E_2N_2	Flat method + Earthing- 100% VC @ 10t/ha
T_8	E_2N_3	Flat method + Earthing - 100% RDF
T_9	E_2N_4	Flat method + Earthing - 50% RDF + 50% VC
T_{10}	E_2N_5	Flat method + Earthing - 75% RDF + 25% VC
T_{11}	E_3N_1	Ridge method- control
T_{12}	E_3N_2	Ridge method- 100% VC @ 10t/ha
T_{13}	E_3N_3	Ridge method- 100% RDF
T_{14}	E_3N_4	Ridge method- 50% RDF + 50% VC
T_{15}	E_3N_5	Ridge method- 75% RDF + 25% VC

3.6. Details of the field experiment and layout

The details of the field experiment and layout have been presented in table. 3.2 and figure. 2 below:

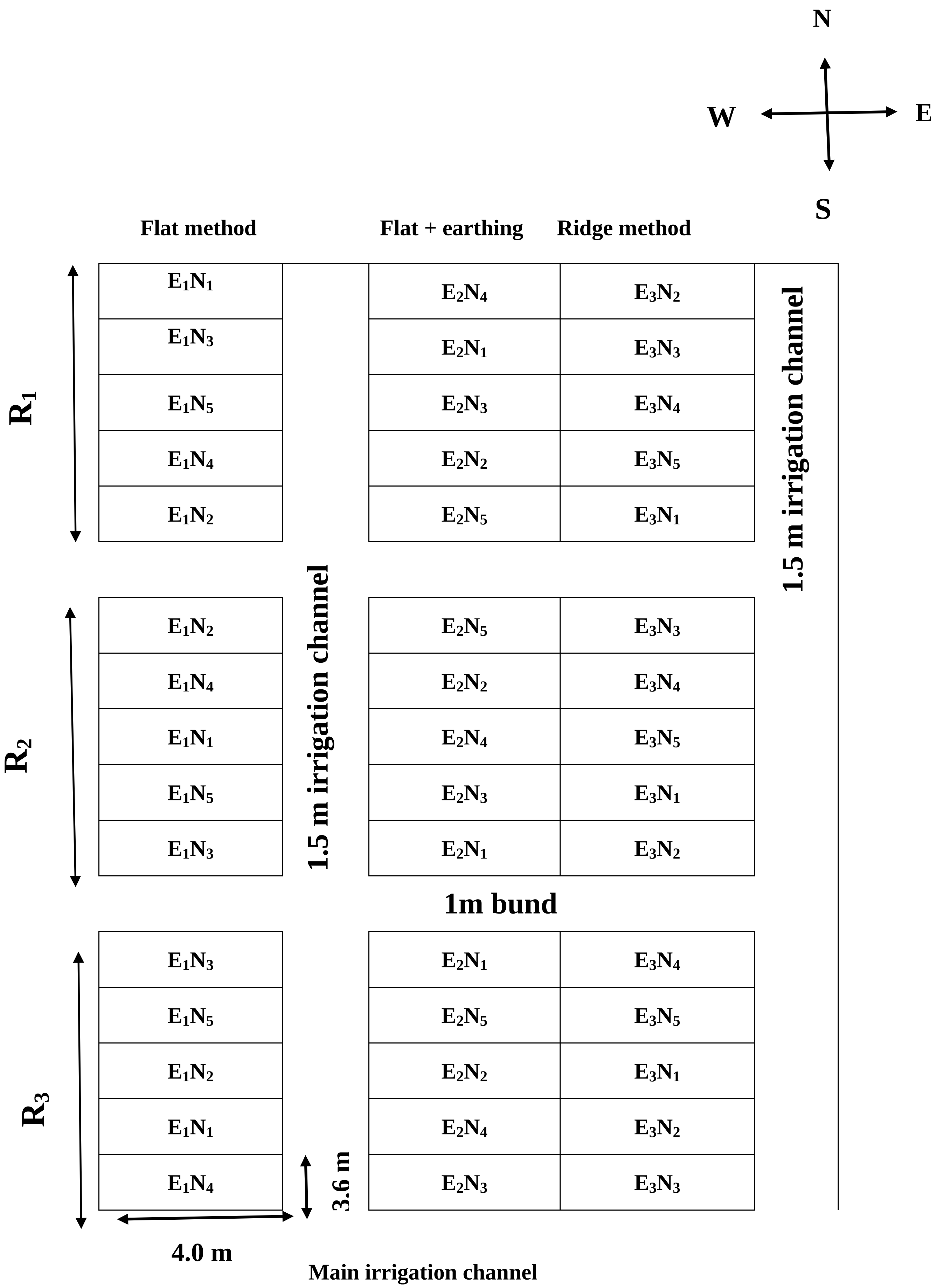


Figure 2: Layout of the field experiment

Table 3.2. Layout details

S. No.	Particulars	Remark
1	Site of experiment	Instructional Dairy Farm (IDF), Nagla, Pantnagar (Udham Singh Nagar), Uttarakhand
2	Experimental design	Split Plot Design (SPD)
3	Replication	03
4	Treatment	15
5	Total no of plots	45
6	Gross Plot size	3.6 m × 4.0 m = 14.4 m^2
7	Net Plot size	2.4 m × 3.0 m= 7.2 m^2
8	Seed rate	30 kg/ha.
9	Variety	V.L. Baby Corn- 1.
10	Spacing	60 cm ×15 cm
11	100% (RDF) N: P_2O_5: K_2O dose	180:60:40 kg/ha
12	Varietal characteristics	Released from VPKAS, Almora in 2005, extra early in maturity, yellow in colour and average baby corn yield 12-13 q/ha.

3.7. Cultural operations

The details of the pre and post planting cultural operations performed during experimental period are given below in table. 3.3;

Table. 3.3. Cultural operations

S.No.	Cultural operation	Date	Note
A. Pre- planting			
1	Ploughing, harrowing and planking	01 June 2018	Tractor mounted mould board plough, disc harrow and leveler
2	Layout	01 June 2018	Manually
3	Vermicompost application	01 June 2018	Manually (One week before sowing)
3	Basal fertilizer application	07 June 2018	Manually
4	Sowing	07 June 2018	Manually
5	Bunding	07 June 2018	Manually
B. Post- planting			
1	Herbicide spray	08 June 2018	Pendimethalin @ 1.0 kg ai/ha.
2	Thinning	20 June 2018	Manually
3	Earthing	02 June 2018 (25 DAS)	Manually
4	Weeding	07 July 2018	Manually
5	Insecticide spray	08 July 2018	Spray of Chlorpyriphos 36 SL@ 2 ml/L water
6	Top dressing of urea	1^{st} - 22 June 2018 2^{nd} - 09 July 2018	Manually
7	Irrigation	21 June 2018	Electric pump
8	Harvesting	1^{st} pick- 28 July 2018 2^{nd} pick- 30 July 2018 3^{rd} pick- 03 August 2018 4^{th} pick- 06 August 2018 5^{th} pick- 08 August 2018	Manually

3.7. Agronomic operations

3.7.1. Field preparation

After the harvesting of previous crop, land was ploughed by tractor mounted mould board plough once, followed by 2 cross harrowing with the help of disc harrow to make pulverized seed bed, later, the planking was done to level the land. Ridges were made manually for the purpose of ridge planting.

3.7.2. Manure & fertilizer application

Calculated dose of vermicompost was applied on the plot receiving treatment N_2, N_4 and N_5 one week prior to sowing. The chemical fertilizers i.e. urea, NPK (12:32:16) were used as a N, P and K source and their calculated dose was applied according to treatments. Full dose of P and K was applied as a basal while nitrogen was applied in 3 splits; one third as basal, one third at knee high stage and one third at pre tasseling stage. The vermicompost used for experiment had 1.8, 0.72 and 0.84% nitrogen, phosphorus and potassium, respectively.

3.7.3. Seed and sowing method

The baby corn variety VL- Baby Corn 1 was sown manually on ridges and flat beds. Prior to sowing seed was treated with Carbendazim @ 3 g per kg seed. The furrows were opened at 60 cm apart manually with the help of line opener and seed was drilled at 15 cm interspacing at 4 cm depth.

3.7.4. Gap filling and thinning

After field emergence, the required plant population per plot was maintained by gap filling and thinning after 10 days of crop sowing. For the gap filling, the seedlings of same age were taken from a separate nursery.

3.7.5. Water management

The crop was examined properly and irrigation was given as per crop need and one irrigation was given to crop at 14 DAS.

3.7.6. Weed management

For controlling the weeds, Pendemethilin @ 1 kg a.i./ha as pre emergence herbicide was sprayed with the help of knap sack sprayer followed by one hand weeding at 30 days after sowing.

3.7.7. Plant protection

Kharif planted baby corn has more chances of pest attack due to high temperature and high humidity, therefore one spray of Chlorpyriphos @ 2 ml per liter water was done at 30 days after sowing to protect the crop from sucking and cutting pests.

3.7.8. Harvesting

The baby corn harvesting was started after silk emergence. Three days after silking was taken as the picking time of the baby corn, consequently five picking were done. The harvested baby cob (with husk) and baby corn (without husk) were weighed and yield was expressed in kg per hectare. The fodder yield and cob husk yield was added to get the total fodder yield.

3.8. Observation

The observation on growth and yield attributes of baby corn were recorded at 25, 45 days after sowing and at harvest from each plot. The details of the sampling procedure along with data recording are given below;

3.8.1. Growth parameters

3.8.1.1. Plant stand

The initial plant population was calculated at 20 DAS by counting total number of plants in each plot which was expressed as plants/ha. Similarly, final plant population was calculated before harvesting the crop.

3.8.1.2. Plant height

Ten plants in each plot were selected randomly and tagged. The plant height was measured with the help of wooden scale at 25,45 days after sowing and at harvest. The plant height of the selected plant was measured from base of the plant to the apex of the newly formed leaf and then values were averaged and expressed in cm.

3.8.1.3. Dry matter accumulation

Destructive method was followed for the estimation of dry matter accumulation. Five plants were randomly selected from sampling rows at 25, 45 days after sowing and at harvest stage. Only above ground portion was taken and firstly sun dried for 48 hours, then the plant samples were put in oven at 65 ± 5 ^{0}C temperature for 48 -72 hours or till constant weight achieved. Later dry weight of the oven dry sample was measured and expressed in g per plant. The dry matter per plant at harvest did not include the baby corn dry matter. The dry matter per plant at harvest did not include the baby corn dry matter. The total baby corn and green fodder dry matter production was calculated as follow;

1) Total baby corn dry matter production = Fresh weight of baby corn × Dry matter content (20%)
2) Total green fodder dry matter production = Dry weight per plant × Plant population

3.8.1.4. Leaf area index

The leaf area index was calculated by **"Viticanopy Mobile App"** which was actually designed for grape, therefore first the leaf area was measured manually using the formula given by Sestak (1971) and calibration of the viticanopy app reading was made with reading obtained by manual method. The average leaf area was calculated from randomly selected 3 leaves i.e. large, medium and small from each plot and leaf area was calculated as follow;

$$\text{Leaf area (cm}^2\text{)} = \text{length} \times \text{width} \times \text{correction factor (0.75)}$$

$$\text{Leaf area index} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Ground area per plant (cm}^2\text{)}}$$

Viticanopy app uses the front camera and GPS of smart phone and automatically implements image analysis algorithms on upward looking digital images of canopies and gives LAI. For calculating the LAI from viticanopy mobile app, smart phone was placed on the ground and image of plant canopy was clicked from 3-4 places within the plot and it automatically gave LAI values.

3.8.1.4. Days to 50% tasseling (days)

The days taken to 50% was computed by subtracting the date of sowing to date of 50 % tasseling.

3.8.2. Growth analysis

The assimilatory material accumulation pattern of the plant was calculated by formula of growth analysis (Radford, 1967).

3.8.2.1. Mean crop growth rate ($\overline{CGR}$)

Mean crop growth rate represents increase in weight per unit time per unit area. It was calculated by following formula;

$$\text{Crop growth rate} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where

W_1 = dry weight of plant at time t_1 in unit area (in g)

W_2 = dry weight of plant at time t_2 in unit area (in g)

t_1 = days to 1[st] sampling

t_2 = days to 2[nd] sampling

A = plant area (m^2)

$\overline{CGR}$ was calculated at two growth intervals 25-45 days after sowing and at 45 days after sowing – harvest stage and values were expressed as $g/m^2/day$.

3.8.2.2. Mean relative growth rate ($\overline{RGR}$)

It denotes increase in dry matter per unit dry matter per unit time. It was calculated by following formula;

$$\text{Relative growth rate} = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

Where

W_1 = dry weight of plant at time t_1 (in g)

W_2 = dry weight of plant at time t_2 (in g)

t_1 = days to 1[st] sampling

t_2 = days to 2[nd] sampling

RGR was calculated at two growth intervals 25-45 days after sowing and at 45 days after sowing – harvest stage and was expressed as g/g/day.

3.8.3. Yield attributes

3.8.3.1. Baby cob weight with husk

The baby cobs were harvested from net plot and their weight was taken with husk and was expressed in kg/ha as mentioned below;

$$\text{Baby cob weight with husk (kg/ha)} = \frac{\text{Weight of cobs with husk from net plot}}{\text{Net plot area} \times 1000} \times 10{,}000$$

3.8.3.2. Baby corn length

Length of 10 randomly selected baby cobs (without husk) was taken with the help of meter scale then the values were averaged and were expressed in cm.

3.8.3.3. **Baby corn girth**

Girth of baby cobs (without husk) were measured by Vernier calipers from the top middle and bottom portion of a cob, then, their values were averaged & expressed in cm.

3.8.4. Yield

3.8.4.1. Baby corn yield

The weight of the baby corn harvested from net plot area was taken and then baby corn yield per hectare was calculated with help of following formula;

$$\text{Baby corn yield (kg/ha)} = \frac{\text{Weight of baby corn harvested from net plot(g)}}{\text{Net plot area} \times 1000} \times 10{,}000$$

3.8.4.2. Green forage yield

Green forage was harvested from net plot after harvesting of baby corn and the weight of cob husk was added in green forage yield of each plot and was expressed in t/ha as follows;

$$\text{Green forage yield (t/ha)} = \frac{\text{Green forage yield(kg)}}{\text{Net plot area} \times 1000} \times 10{,}000$$

3.9. Chemical studies

3.9.1. Plant analysis

3.9.1.1. NPK content in plant parts

At the time of harvesting, plant samples were collected from each plots and shade dried for 48 hours then these samples were transferred to hot air oven and dried at 65 ± 5 ^{o}C till samples attained a constant weight. These samples were ground properly and passed through sieve of 0.5 mm mesh size. The chemical analysis of these baby corn and plant samples was done for nitrogen, phosphorus and potassium determination. Prior to chemical analysis sample preparation was done by wet digestion of plant samples than modified micro kjeldal method, phosphoric acid spectrophotometry and flame photometer method were used for determination of N, P and K content, respectively **(Jackson, 1973).**

3.9.1.2. Nutrient uptake

The uptake of nitrogen, phosphorus and potassium in baby corn as well as fodder was estimated with the help of following formula;

$$\text{Nitrogen uptake (kg/ha)} = \frac{\text{N content in sample} \times \text{oven dry yield (kg / ha)}}{100}$$

$$\text{Phosphorus uptake (kg/ha)} = \frac{\text{P content in sample} \times \text{oven dry yield (kg/ha)}}{100}$$

$$\text{Potassium uptake (kg/ha)} = \frac{\text{K content in sample} \times \text{oven dry yield (kg/ha)}}{100}$$

3.9.2. Soil analysis

The representative soil sample was prepared by taking the soil from 5-6 randomly selected area at the depth of 15 cm and mixing it properly. Then half kg of soil was taken for the determination of different soil parameters like soil organic carbon, available nitrogen, phosphorus and potassium content after the harvesting of crop. Walkley and Black's method, alkaline permanganate method, Olsen's method and flame photometry methods were used for estimation of organic C, N, P and K. The conversion factor used for converting P and K to P_2O_5 and K_2O was 2.29 and 1.20, respectively.

3.9.2.1. Apparent nutrient balance

Apparent nutrient balance in soil was calculated by deducting the initial N, P and K content from final nutrient content or the values after crop harvesting.

3.10. Soil microbial study

The soil samples were analyzed for microbial study i.e. Bacteria, Fungi and Actinomycets. The procedure of the microbial analysis is given as follows;

3.10.1. Serial dilution

One gram of soil sample was taken and diluted and homogenized in the autoclaved test tube containing 9 ml of sterilized distilled water and this gave the dilution of $10^{-1.}$ One ml aliquot of 10^{-1} strength was transferred into test tube containing 9 ml water to form dilution of 10^{-2} and up to 10^{-9} dilution was prepared by following the above mentioned procedure.

3.10.2. Media preparation

Readymade media was used for the soil microbiological analysis. The procedure of media preparation along with their composition is given below.

3.10.2.1. Soil extract agar media (Bacteria)

- Suspend 34.25 g of media in 100 ml distilled water.
- Heat to boiling to dissolve the medium completely.

- Sterilize by autoclaving at15 lbs. pressure and 121^{o} C temperature for 15 minutes and cool to 45-50 ^{o}C.

Particulars	Quantity (g/liter water)
Dextrose (Glucose)	1.00
Dipotassium hydrogen phosphate	0.50
Soil extract	17.75
Agar	15.0
pH at 25 ^{o} C	6.8 $\pm$ 0.2

3.10.2.2. Kenknight and Munaier's media (Actinomycets)

- Take 16.4 g media and dissolve it in 1000 ml distilled water.
- Heat to boiling to dissolve the medium completely.
- Sterilize by autoclaving at 15 lbs. pressure and 121^{o} C temperature for 15 minutes and cool to 45-50 ^{o}C.

Particular	Quantity (g/liter water)
Dextrose	1.0
Sodium nitrate	0.1
Potassium di- hydrogen phosphate	0.1
Potassium chloride	0.1
Magnesium disulphate heptahydrate	0.1
Agar- agar	15.0

3.10.2.3. Potato dextrose agar media (Fungi)

- Suspend 39.0 g media in 100 ml distilled water.
- Boil the media to dissolve it in water completely.
- Sterilize by autoclaving at15 lbs. pressure and 121^{o} C temperature for 15 minutes and cool to 45-50 ^{o} C.

Particular	Quantity (g/liter water)
Potato infusion form	200.0
Dextrose	20.0
Agar	15.0
pH at 25 ^{o} C	5.6 $\pm$ 0.2

3.10.3. Inoculation of soil samples in media

1) The samples, media and petri plate were put inside laminar assembly and floor of the assembly was sterilized via UV radiation.
2) 10 ml of required selective media was poured in each sterilized petri plate.
3) 1 ml aliquot of required dilution was poured and spread in the solidified media and rotated clockwise and anticlockwise to ensure uniform spreading (10^{-2} for fungi, 10^{-4} for bacteria and actinomycets).
4) The media was allowed to cool down and petri plate was covered with lid and sealed with the help of paraffin wax sheet and details were marked on the lid of petri plates.
5) Petri plates inoculated with soil solution were incubated at 28 ^{0}C inside the BOD incubator for different time period (2 days for fungi, 4 days for bacteria and 1 week for actinomycets).
6) Total bacterial, fungal and actinomycets count was expressed in colony forming units (C.F.U.) with the help of following formula;

$$\text{Number of microbes (C.F.U. g}^{-1}\text{ soil)} = \frac{\text{Number of colonies} \times \text{dilution factor}}{\text{Weight of soil taken} \times \text{dilution per ml}}$$

3.10. Quality parameter

3.10.1. Total soluble solids (TSS)

Five baby corn were selected randomly from each plot and their juice was extracted after crushing inside the muslin cloth. One or two drop of juice was dropped in the screen of hand refractometer and TSS reading were noted down and expressed in percentage.

3.10.2. Protein content in baby corn

Nitrogen content of baby corn was estimated and protein content of baby corn was calculated by multiplying the factor 6.25 into nitrogen content of baby corn and expressed in percentage as mentioned below;

$$\text{Protein content (\%)} = \text{Nitrogen content (\%)} \times 6.25$$

3.11. Economics

3.11.1. Cost of cultivation

Treatment wise cost of cultivation was calculated by adding fixed and variable cost of all the inputs used for the crop cultivation as per the local market rate and expressed in Rs per hectare.

3.11.2. Gross return

The computation of gross return in Rs/ha was done by adding the value of baby corn and green fodder with the help of following formula;

Gross return (Rs/ha) = {baby corn yield (kg/ha) × selling price of baby corn (Rs/ha)} + {green fodder yield (kg/ha) × selling price of green fodder (Rs/ha)}

3.11.3. Net return

The net return was calculated by subtracting the expenditure occurred in baby corn production from gross return as mentioned below;

Net return (Rs/ha) = Gross return – Cost of cultivation

3.11.4. Benefit: Cost ratio (B:C ratio)

The benefit-cost ratio was calculated with respect to net return as given below;

$$\text{B:C ratio} = \frac{\text{Gross return (Rs / ha)}}{\text{Cost of cultivation (Rs / ha)}}$$

3.11.5. Net profit per day

The net profit per day was computed by dividing the value of net profit to total crop duration as mentioned below;

$$\text{Net profit per day (Rs/ha/day)} = \frac{\text{Net return(Rs / ha)}}{\text{Crop duration (60 days)}}$$

3.12. Statistical Analysis

The statistical analysis of data on various parameters of growth, yield and quality was done by using Split plot design as described by Gomez and Gomez (1984) with the help of standard approach of Analysis of Variance (ANOVA). The critical difference was also calculated to test the significance of difference between two treatments if F test was found significant at 5% level of significance.

Results & Discussion

CHAPTER-4 RESULTS AND DISCUSSION

The experimental findings based on the data recorded during the course of investigation entitled “**EFFECT OF ESTABLISHMENT METHOD AND NUTRIENT MANAGEMENT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF BABY CORN (*Zea mays* L.)”** is presented in this chapter in the form of tables and illustrated through figures wherever necessary.

4.1. Plant growth studies

4.1.1. Plant population and mortality percentage

The plant population (except initial) and mortality percentage both varied significantly under establishment methods, however, there was no significant influence of nutrient management (Table. 4.1 and Appendix. II & III).

4.1.1.1. Effect of establishment method

The initial plant population was recorded higher under ridge planting followed by flat + earthing and flat method of planting but the final plant population differed significantly under different establishment methods in which the ridge planting method had significantly higher plant population than flat planting that was statistically at par with flat + earthing. The flat method of planting witnessed significantly highest mortality % that was 12 and 13% higher than flat + earthing and ridge method, respectively. The higher plant population and lower mortality percentage under ridge planting was caused due to better aeration and protection of plants from water logging. **Painyuli (2010)** also reported higher plant population of sweet corn at ridge planting followed by flat + earthing and flat planting, respectively.

4.1.1.2. Effect of nutrient management

The plant population (initial and final) and mortality percentage remained non-significant at all nutrient management options however the highest plant population was recorded with equal values at both 75% RDF + 25% VC and 100 % RDF followed by 50% RDF + 50% VC, 100% VC and lowest in control. The highest and lowest mortality percentage was recorded at control and 100% RDF, respectively. The variation in plant population was mainly due varied field emergence.

Table 4.1. Effect of establishment method and nutrient management on plant population, mortality percentage and plant height at different growth stages

Treatment	Plant population (000 plants/ha)		Mortality %	Plant height (cm)		
	Initial	Final		25 DAS	45 DAS	Harvest
A) Establishment method						
Flat	104.86	94.85	9.54	46	173	224
*Flat + Earthing	106.86	97.88	8.40	47	176	235
Ridge	107.74	98.89	8.30	49	181	240
SEm±	0.96	1.00	0.22	0.5	0.3	1.4
CD (P=0.05)	NS	3.00	0.90	02	01	06
B) Nutrient management						
Control	105.4	96.03	8.85	44	167	192
100% VC @ 10 t/ha	106.3	97.00	8.80	47	174	231
100% RDF	107.2	97.98	8.50	49	181	251
50% RDF+ 50% VC	106.4	97.06	8.70	47	177	239
75% RDF + 25% VC	107.2	97.98	8.60	51	183	252
SEm±	0.17	0.52	0.14	01	1.3	2.0
CD (P= 0.05)	NS	NS	NS	03	04	06

***Flat + Earthing = Flat followed by earthing**

4.1.2. Plant height

The plant height of the baby corn was increased with advancement of the crop age up to harvest. The establishment method and nutrient management had significant effect on plant height at all growth stages. (Table. 4.1 and Appendix. IV).

4.1.2.1. Effect of establishment method

The tallest plants of baby corn were recorded under ridge planting at all growth stages but remained at par with flat + earthing at all the stages except 45 DAS. Flat planting produced significantly shorter plants at all the stages however it remained non-significant with flat + earthing at 25 DAS.This might be due to better aeration and availability of nutrients and moisture. Flat planting had more chances of water stagnation, while rest two planting methods had better drainage which created better environment for root development thus it enhanced nutrient uptake and ensured better water availability.

4.1.2.2. Effect of nutrient management

The tallest plants were recorded at 75% RDF + 25% VC but it did not differ significantly with 100% recommended dose of fertilizers at all the stages. The plant height remained non – significant under 100% VC and 50% RDF + 50% VC at 25 DAS and 45 DAS. At harvest 50% RDF + 50% VC produced significantly taller plants than 100% VC. The shortest plants were recorded under control at all growth stages. Taller plants were due to better availability of essential nutrients and increased photosynthetic formation. The treatment having 50% and 100% VC had lower plant height mainly due to slow release of nutrients that did not match with crop demand. These results are in close conformity with the results observed by **Dadarwal *et al.* (2009).** The interaction effect between establishment method and nutrient management was found non-significant at all growth stages.

4.1.3. Dry matter accumulation per plant

The dry matter accumulation per plant increased gradually with advancement of the crop age. The establishment methods and different nutrient management options had significant effect on dry matter accumulation at all growth stages except establishment method at 25 DAS (Table. 4.2, fig. 4.1 and appendix V).

Table 4.2. Effect of establishment method and nutrient management on dry matter accumulation at different growth stages

Treatment	Dry matter accumulation (g/plant)		
	25 DAS	45 DAS	Harvest
A) Establishment method			
Flat	11.00	112.54	131.27
*Flat + Earthing	11.33	127.26	141.10
Ridge	12.36	135.19	147.48
SEm±	0.51	0.85	1.06
CD (P=0.05)	NS	3.41	4.30
B) Nutrient management			
Control	8.59	118.37	129.19
100% VC @ 10 t/ha	9.24	121.71	136.23
100% RDF	13.69	129.16	144.31
50% RDF+ 50% VC	11.79	125.41	139.94
75% RDF + 25% VC	14.49	131.32	150.09
SEm±	0.81	1.09	1.39
CD (P= 0.05)	2.37	3.19	4.07

***Flat + earthing = Flat followed by earthing**

4.1.3.1. Effect of establishment method

The ridge planting produced significantly higher dry matter at all growth stages except at 25 DAS, while the lowest dry matter was produced at flat planting at all growth stages. At harvest, ridge planting accumulated 4.5 and 12% higher dry matter than flat + earthing and flat method, respectively. The higher dry matter production was due to better plant growth including higher plant height mainly because of ridges provided greater aeration and moisture availability. Similar observations were also reported by **Singh and Vashist (2015).**

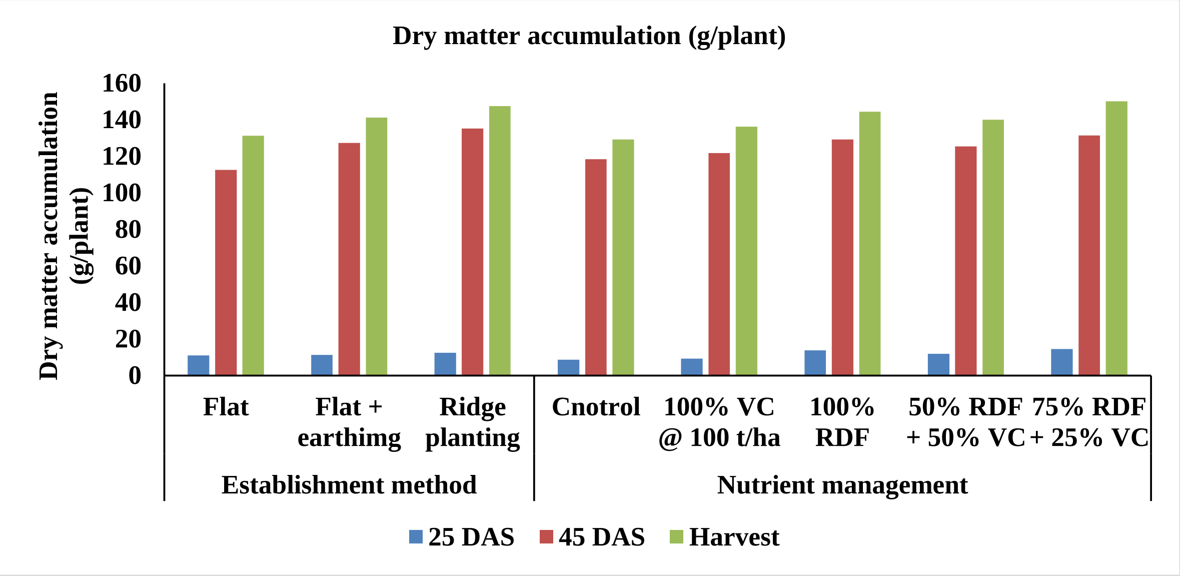


Fig. 4.1. Effect of establishment method and nutrient management on dry matter accumulation per plant at different growth stages

4.1.3.2. Effect of nutrient management

The 75% RDF + 25% VC produced higher dry matter at all growth stages however, it did not differ significantly with 100% RDF up to 45 DAS. The dry matter production remained non- significant under 100% RDF and 50% RDF + 50% VC at 25 DAS. At 25 and 45 DAS, 50% RDF + 50% VC produced significantly higher dry matter than 100% VC. However, 100% VC produced statistically similar dry matter with control and 50% RDF + 50% VC at 25 DAS and harvest, respectively. The significantly lower dry matter accumulation was observed under control at all the growth stages except at 25 DAS where it was remained non-significant with 100 % VC. The higher plant height and leaf area index resulted into higher biomass accumulation. Similarly, increase in dry matter production through the integration of fertilizers with vermicompost was also reported by **Prasad and Naik (2013).**

4.1.4. Total dry matter production of baby corn and green fodder

The dry matter production of baby corn, green fodder and total was influenced significantly by establishment methods and nutrient management strategies (Table. 4.3 and appendix VI).

4.1.4.1. Effect of establishment method

Significantly highest baby corn dry matter production was recorded under ridge planting that had 8.5 and 16.7% higher values than flat + earthing and flat planting, respectively. Similarly, baby corn produced under flat followed by earthing produced 7.6% higher dry matter production than flat planting method. The dry matter production from green fodder also differed significantly among plant establishment methods with highest under ridge planting that gave 5.6 and 17.1% higher dry matter production than flat + earthing and flat method, respectively. Similarly, the flat + earthing produced 11% higher dry matter than flat planting method. The total dry matter production from baby corn and green fodder influenced significantly by establishment methods and followed the above trend with highest value under ridge planting accounting 5.7 and 17.1% greater than flat + earthing and flat method, respectively.

Table 4.3. Effect of establishment method and nutrient management on total dry matter production of baby corn and green fodder at harvest

Treatment	Dry matter production (kg/ha)		
	Baby corn	Green fodder	Total
A) Establishment method			
Flat	251	12457	12708
*Flat + Earthing	270	13816	14086
Ridge	293	14590	14883
SEm$\pm$	03	110	108
CD (P=0.05)	10	442	437
B) Nutrient management			
Control	136	12418	12554
100% VC @ 10 t/ha	255	13226	13481
100% RDF	328	14151	14479
50% RDF+ 50% VC	289	13593	13883
75% RDF + 25% VC	349	14717	15066
SEm$\pm$	07	136	135
CD (P= 0.05)	22	399	397

***Flat + earthing = Flat followed by earthing**

4.1.4.2. Effect of nutrient management

The application of 75% RDF + 25% VC produced significantly higher dry matter of baby corn accounting nearly 6% higher than 100% RDF though both were non-significant. The combined application of fertilizers with vermicompost i.e. 50% RDF + 50% VC and 75% RDF + 25% VC produced 13.3 and 36.4% higher baby corn dry matter production than 100% VC, however, all differed significantly. The dry matter production from green fodder was recorded highest at 75% RDF + 25% VC that gave 4, 8.2 and 10.5% higher dry matter than 100% RDF, 50% RDF + 50% VC and 100% VC, respectively. The total dry matter production from baby corn and green fodder influenced significantly by nutrient management and significantly highest dry matter production was recorded at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC and 100% VC accounting 4, 8.5 and 11.7% higher values, respectively. The 100% RDF produced 4.2 and 7.4% higher dry matter than 50% RDF + 50% VC and 100% VC, respectively.

4.1.5. Leaf area index (LAI)

The LAI of baby corn increased progressively up to 45 DAS and later declined and it was also influenced significantly by establishment methods and nutrient management strategies (Table. 4.4 and appendix VII).

4.1.5.1. Effect of establishment method

The highest LAI of baby corn was recorded under ridge planting method followed by flat + earthing and the lowest LAI was found in flat planting method at all the growth stages. The higher LAI was the result of higher leaf area. **Balsaubramaniyan *et al.* (2001)** also reported higher LAI of maize at ridge planting method.

4.1.5.2. Effect of nutrient management

Significantly highest LAI was recorded under 75% RDF + 25% VC but it was significantly equal to 100% RDF at all the stages. At 25 DAS, 50% RDF + 50% VC had significantly higher LAI than 100% VC but it was significantly equal to 100% VC and 100% RDF at both 45 DAS and harvest. The control recorded significantly lowest LAI. The higher LAI was the result of higher leaf area and more number of leaves. **Haq (2006)** also reported the higher LAI at integrated nutrient management with organics. The lower LAI at harvest stage was caused due to increasing trend of leaf senescence. **Kumar (2016)** also reported lower LAI of maize at harvest compared to 30 and 60 DAS. The interaction between establishment methods and nutrient management options was found non- significant at all the growth stages.

4.1.6. SPAD values

SPAD reading is the indication of chlorophyll content in leaves and it varied significantly at tasseling stage under different establishment methods and nutrient management strategies (Table4.4 and appendix X).

Table 4.4. Effect of establishment method and nutrient management on leaf area index and SPAD values at different growth stages

Treatment	Leaf area index			SPAD values
	25 DAS	45 DAS	Harvest	Tasseling stage
A) Establishment method				
Flat	0.17	3.54	3.39	44.17
*Flat + Earthing	0.18	3.75	3.49	45.00
Ridge	0.28	4.38	4.12	45.78
SEm ±	0.01	0.12	0.13	0.07
CD (P=0.05)	0.04	0.47	0.55	0.28
B) Nutrient management				
Control	0.16	3.17	2.97	41.79
100% VC @ 10 t/ha	0.19	3.65	3.49	43.92
100% RDF	0.23	4.18	4.02	46.29
50% RDF+ 50% VC	0.22	4.07	3.79	45.34
75% RDF + 25% VC	0.24	4.36	4.07	47.59
SEm ±	0.01	0.14	0.12	0.15
CD (P= 0.05)	0.02	0.42	0.34	0.45

***Flat + earthing = Flat followed by earthing**

4.1.6.1. Effect of establishment methods

The highest SPAD reading was recorded significantly under ridge planting followed by flat + earthing and significantly lowest reading was measured under flat planting method. The higher SPAD reading was mainly due to more greenness of leaves.

4.1.6.2. Effect of nutrient management

The SPAD reading was recorded significantly highest at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC and 100% VC, respectively and the lowest SPAD value was found at control. Greater availability of essential nutrients including nitrogen improves the greenness of leaves resulting into higher SPAD reading. **Pallavi *et al.* (2016)** also reported higher SPAD values at 75% RDF + 25 % VC. The interaction was found significant between establishment method and nutrient management option at tasseling stage.

4.1.7. Mean crop growth rate ($\overline{\text{CGR}}$)

The mean crop growth rate of baby corn was influenced significantly by establishment methods and nutrient management strategies at all the growth stages except at 25 DAS-harvest where establishment method had non-significant effect on it. The maximum crop growth rate was attained between 25-45 DAS and after that it goes on decreasing up to harvest (Table. 4.5 and appendix VIII).

4.1.7.1. Effect of establishment method

The ridge planting had significantly higher crop growth rate at 25-45 DAS followed by flat + earthing and flat method, respectively but at 45 DAS-harvest reverse trend was observed i.e. flat method recorded higher $\overline{\text{CGR}}$ followed by flat+earthing and ridge being non- significant with each other. The $\overline{\text{CGR}}$ is the index of rate of dry matter accumulation per day per unit area so higher $\overline{\text{CGR}}$ was due to higher dry matter accumulation per unit area per unit time.

4.1.7.2. Effect of nutrient management

The significantly highest $\overline{\text{CGR}}$ was recorded under 75% RDF + 25% VC at 0-25 and 25-45 DAS but it was remained non-significant with 100% RDF, 50% RDF + 50% VC however, at 45-harvest 100% VC also became non-significant with these treatment. The significantly lowest value was recorded under control at all the stages that was statistically at par with 100% VC and 50% RDF + 50% VC. The higher $\overline{\text{CGR}}$ was due to more dry matter accumulation under 100 % RDF and its substitution with vermicompost however, at later stage 100% VC also gave equivalent $\overline{\text{CGR}}$ as it started releasing nutrients that was used for plant dry matter production.

4.1.8. Mean relative growth rate ($\overline{\text{RGR}}$)

The mean relative growth rate of baby corn was influenced significantly by establishment methods and nutrient management options and it tends to decrease with the advancement of crop age as the major parts of the accumulated phtotosynthates gets diverted towards reproductive parts (Table. 4.5 and appendix IX).

4.1.8.1. Effect of establishment method

The significantly highest $\overline{\text{RGR}}$ was recorded under ridge planting that remained non-significant with flat + earthing and lowest under flat method at 25-45 DAS, however, at 45

DAS – harvest flat method recorded significantly highest $\overline{RGR}$ and lowest under ridge planting. The lower $\overline{RGR}$ under ridge planting than flat method at later stage was caused due to early crop establishment under ridges.

4.1.8.2. Effect of nutrient management

The highest $\overline{RGR}$ was recorded significantly under 75% RDF + 25% VC at 25-45 DAS that remained statistically at par with 100% RDF, 50% RDF + 50% VC and 100% VC and significantly lowest under control that was significantly similar to 100% VC and 50% RDF + 50% VC. At, 45 DAS-harvest nutrient management had non-significant effect on $\overline{RGR}$ however, numerically highest and lowest $\overline{RGR}$ was recorded at control and 100% RDF and 75% RDF + 25% VC, respectively. The treatments with higher dose of inorganic fertilizer were leading towards maturity earlier than control and resulted in declined rate of translocation of phtotosynthates in their tissues due to faster drying of cell sap which might be responsible for lower $\overline{RGR}$ in these treatments at later stages. **Das *et al.* (2009)** also observed similar trend of $\overline{RGR}$ under nutrient management.

Table 4.5. Effect of establishment method and nutrient management on mean crop growth rate ($\overline{CGR}$), relative crop growth rate ($\overline{RGR}$) and days to 50% tasseling

Treatment	$\overline{CGR}$ (g/m^2/day)		$\overline{RGR}$ (g/g/day)		Days to 50% silking
	25-45 DAS	45-harvest	25-45 DAS	45-harvest	
A) Establishment method					
Flat	50.86	13.881	0.070	0.010	51.0
*Flat + Earthing	58.85	10.255	0.090	0.007	50.0
Ridge	62.68	9.105	0.090	0.006	49.0
SEm$\pm$	0.72	1.020	0.003	0.001	0.2
CD (P=0.05)	2.90	NS	0.010	0.003	1.0
B) Nutrient management					
Control	55.44	8.01	0.084	0.009	53.0
100% VC @ 10 t/ha	56.93	10.75	0.087	0.008	51.0
100% RDF	58.04	11.96	0.092	0.007	48.0
50% RDF+ 50% VC	57.56	10.77	0.088	0.008	50.0
75% RDF + 25% VC	59.35	13.90	0.093	0.007	49.0
SEm$\pm$	0.74	1.25	0.002	0.001	0.3
CD (P= 0.05)	2.18	3.68	0.006	NS	1.0

*** Flat + earthing = Flat followed by earthing**

4.1.9. Days to 50% tasseling

The data presented in table. 4.5 and appendix. X clearly indicate that time taken to 50% tasseling was influenced significantly by establishment methods and nutrient management options.

4.1.9.1. Effect of establishment method

The significantly longest time to 50% tasseling was taken by flat method followed by flat + earthing. However, ridge planting took minimum days to 50% tasseling. The increased time to 50% tasseling might be due to insufficient crop establishment under flat method **(Tanveer *et al.*, 2014).**

4.1.9.2. Effect of nutrient management

In general, control i.e. no fertilizer application, took significantly maximum days to 50% tasseling and 50% RDF + 50% VC took statistically similar says to 100% VC, and 75% RDF + 25% VC. The significantly lowest days to 50% tasseling were taken by 100% RDF. The lower days taken to 50% tasseling was caused due to radially supply of nitrogen from inorganic sources that led to higher LAI and dry matter accumulation which ultimately increased energy level for tasseling. Similar findings were reported by **Kaur (2013)**. The interaction effect between establishment methods and nutrient management strategies was non- significant for days taken to 50% tasseling.

4.2. Yield attributes

4.2.1. Length of baby corn

The data presented in the table. 4.6 and appendix. XI indicate that length of baby corn was increased up to 4th pick and was influenced significantly by nutrient management.

4.2.1.1. Effect of establishment method

The establishment methods did not have significant effect on baby corn length**.** However, the highest baby corn length was recorded under ridge planting in all the pickings followed by flat+ earthing and flat method of planting except at 5th pick where, flat + earthing recorded same baby corn length as recorded by ridge method. **Painyuli (2010)** also reported non-significant effect of planting methods on sweet corn length with higher values at ridge planting.

4.2.1.2. Effect of nutrient management

At 1st pick, 100% RDF recorded significantly higher length of baby corn than control that was statistically equal to 75% RDF + 25% VC, 50% RDF +50% VC and 100% VC. At 2nd pick, similar trend was observed except that 50% RDF +50% VC produced significantly lower length of baby corn than 100% RDF but it was remained significantly similar to 75% RDF + 25% VC and 100% VC. However, at 3rd, 4th and 5th pick 75% RDF + 25% VC recorded significantly higher baby corn length than control and was statistically similar to 100% RDF, 50% RDF +50% VC and 100% VC. The average baby corn length recorded significantly higher at 100 % RDF than 50% RDF +50% VC, 100% VC and control that was statistically at par with 75% RDF + 25% VC, however, 50% RDF +50% VC produced significantly similar length of baby corn to 100% VC and 75% RDF + 25% VC. The proper supply of nitrogen resulted in better nutrient uptake and increased translocation of phtotosynthates towards sink and ultimately responsible for increased baby corn length. **Nanjappa *et al.* (2001)** also reported higher yield attributes of maize at 75% RDF + 2.7t/ha vermicompost application. The interaction between establishment methods and nutrient management options was remained non-significant.

Table 4.6. Effect of establishment method and nutrient management on length of baby corn at different picking

Treatment	**Baby corn length (cm)**					
	1st pick	**2nd pick**	**3rd pick**	**4th pick**	**5th pick**	**Average**
A) Establishment method						
Flat	7.80	8.02	8.50	8.75	8.30	8.29
*Flat + Earthing	7.96	8.10	8.60	8.76	8.33	8.34
Ridge	8.07	8.21	8.63	8.77	8.33	8.40
SEm $\pm$	0.10	0.12	0.05	0.11	0.08	0.016
CD (P=0.05)	NS	NS	NS	NS	NS	NS
B) Nutrient management						
Control	6.36	6.48	7.78	7.86	7.56	7.21
100% VC @ 10 t/ha	8.17	8.22	8.62	8.82	8.50	8.48
100 % RDF	8.68	8.81	8.81	9.01	8.50	8.76
50% RDF+ 50% VC	8.26	8.33	8.72	9.00	8.50	8.56
75% RDF + 25% VC	8.34	8.70	8.91	9.11	8.51	8.71
SEm $\pm$	0.17	0.13	0.12	0.13	0.12	0.06
CD (P= 0.05)	0.51	0.40	0.35	0.40	0.35	0.18

***Flat + earthing = Flat followed by earthing**

4.2.2. Diameter of baby corn

The diameter of baby corn was increased up to 4th pick and differed significantly by different nutrient management options, however there was no significant influence of establishment methods (Table. 4.7 and Appendix. XII).

4.2.2.1. Effect of establishment method

The highest and lowest diameter of baby corn was recorded under ridge planting and flat planting, respectively at all the pickings but both were non-significant to each other. **Singh (2011)** also reported non-significant effect of planting methods on cob diameter of maize.

4.2.2.2. Effect of nutrient management

The higher diameter of baby corn was recorded under 100% RDF followed by 75% RDF + 25% VC, 50% RDF + 50% VC and 100% VC at 1st, 2nd and 3rd picking, however baby corn produced at 4th and 5th picking had higher diameter under 75% RDF + 25% VC than 100% RDF but both increments were non-significant with each other. The average baby corn diameter was recorded non-significant among 75% RDF + 25% VC and 100% RDF but significantly higher than 50% RDF + 50% VC and 100% VC. The

Table 4.7. Effect of establishment method and nutrient management on diameter of baby corn at different picking

Treatment	Baby corn diameter (cm)					
	1st pick	2nd pick	3rd pick	4th pick	5th pick	Average
A) Establishment method						
Flat	4.14	4.17	4.66	4.78	4.43	4.43
*Flat + Earthing	4.14	4.38	4.78	4.86	4.48	4.53
Ridge	4.17	4.47	4.83	4.90	4.54	4.58
SEm ±	0.05	0.09	0.07	0.07	0.11	0.05
CD (P=0.05)	NS	NS	NS	NS	NS	NS
B) Nutrient management						
Control	3.64	4.02	4.40	4.48	4.18	4.14
100% VC @ 10 t/ha	4.20	4.21	4.73	4.86	4.46	4.50
100% RDF	4.39	4.59	4.96	4.98	4.64	4.71
50% RDF+ 50% VC	4.21	4.27	4.77	4.89	4.49	4.52
75% RDF + 25% VC	4.26	4.58	4.94	5.07	4.68	4.70
SEm ±	0.09	0.10	0.10	0.13	0.10	0.05
CD (P= 0.05)	0.27	0.29	0.28	0.39	0.30	0.14

*Flat + earthing = Flat followed by earthing lowest baby corn diameter was produced at control. The higher baby corn diameter was mainly due to better availability of nutrient in proper amount during reproductive phase of the crop. These findings are in close conformity with the results obtained by **Thavaprakash *et al*. (2005)**. The interaction was found non-significant.

4.3. Yield

4.3.1. Baby cob yield

The data depicted in the table. 4.6 and appendix XIII revealed that establishment methods and nutrient management had significant effect on baby cob yield at all the pickings and it increased up to 3rd pick.

4.3.1.1. Effect of establishment method

The baby cob yield was influenced significantly by establishment methods and the highest baby cob yield was recorded under ridge planting at 1st pick followed by flat + earthing and significantly lowest under flat planting. At 2nd,3rd, 4th and 5th pick, the highest baby cob yield was weighed under ridge planting that remained statistically at par with flat + earthing and lowest under flat method. The total baby corn yield was again recorded significantly highest at ridge planting with 7 and 16.5% higher than flat+ earthing and flat method, respectively. Similarly, flat + earthing produced 8.5% higher baby cob yield than flat method. The higher cob yield was the result of higher length and girth of cobs. **Rasheed *et al*. (2003)** also reported higher grain yield of maize at ridge planting**.**

4.2.2.2. Effect of nutrient management

The baby cob yield recorded significantly higher under 100% RDF at 1st pick that was significantly similar to 75% RDF + 25% VC but application of 100% VC produced significantly lower baby cob yield than 50% RDF + 50% VC. At 2nd pick, the highest baby cob yield was weighed at 75% RDF + 25% VC that remained non-significant with 100% RDF. At 3rd pick, 75% RDF + 25% VC again recorded significantly higher baby cob yield than 100% RDF, 50% RDF + 50% VC and 100% VC and significantly lowest under control. At 4th and 5th pick, the baby cob yield was found significantly higher at application of 75% RDF + 25% VC that was statistically at par with 100% RDF. The application of 50% RDF + 50% VC was found statistically equal to 100% VC but significantly higher than control at 3rd and 4th pick. At 2nd and 5th pick, application of 100% VC gave significantly lower baby cob yield than 50% RDF + 50% VC. The total baby cob yield was found significantly highest at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC and 100% VC, respectively and significantly lowest at control. The treatment 75% RDF + 25% VC produced 3.5 and 15.6% higher baby cob yield than 100% RDF and 50% RDF + 50% VC, respectively. Application of 100% RDF was found superior than 100% VC and produced 30% higher baby cob yield. The baby cob yield was increased nearly by 86 and 141% higher under 100% VC and 100% RDF, respectively than control.

Table 4.8. Effect of establishment method and nutrient management on baby cob yield

Treatment	Baby cob yield (kg/ha)					
	1st pick	2nd pick	3rd pick	4th pick	5th pick	Total
A) Establishment method						
Flat	578	1120	1495	1089	580	4862
*Flat + Earthing	626	1215	1636	1135	658	5269
Ridge	671	1296	1779	1238	684	5668
SEm ±	10	22	41	29	11	42
CD (P=0.05)	40	87	167	117	43	170
B) Nutrient management						
Control	205	360	888	802	392	2647
100% VC @ 10 t/ha	506	1030	1641	1139	610	4926
100% RDF	865	1591	1900	1298	749	6402
50% RDF+ 50% VC	706	1434	1736	1189	667	5730
75% RDF + 25% VC	843	1638	2018	1342	785	6626
SEm ±	11	34	37	30	17	60
CD (P= 0.05)	32	101	109	90	51	177

***Flat + earthing = Flat followed by earthing**

The yield improvement through integration of vermicompost with fertilizers was caused due to timely availability of essential nutrients along with increased microbial activity and plant soil - microbes interaction. **Nanjappa *et al.* (2001)** also reported significantly higher maize yield at 75% RDF + 2.5 t/ha vermicompost application than sole application of organic and chemical fertilizers. The interaction effect was found non - significant between establishment methods and nutrient management strategies at all the pickings and total except at 1st pick.

4.3.2. Baby corn yield

The baby corn yield was significantly influenced by different establishment methods and nutrient management strategies at all the pickings and it increased up to 3rd pick (Table. 4.9, fig. 4.2 and appendix XIV).

4.3.1.1. Effect of establishment method

In general, highest baby corn yield was recorded under ridge planting followed by flat + earthing and flat planting at all the picking and total baby corn yield. At 1st pick, baby corn yield was recorded significantly highest under ridge planting followed by flat + earthing and significantly lowest under flat method. At 2nd and 5th pick significantly highest baby corn yield was noticed at ridge planting that remained statistically at par with flat + earthing and significantly lowest under flat planting. At 3rd pick, ridge planting again produced significantly higher baby corn yield than flat planting but flat + earthing remained non- significant with flat method and ridge planting. At 4th pick, significantly higher baby corn yield was noticed under ridge planting than other methods but flat method was found statistically similar to flat + earthing. The total baby corn yield was recorded significantly higher at ridge planting followed by flat + earthing and flat method, respectively with 7 and 14% higher baby corn yield than flat + earthing and flat method. Similarly, flat + earthing produced 8.5% higher baby corn yield than flat method. The percent production of baby corn under different establishment methods indicated that trend of baby corn production was almost similar under different pickings.

4.2.2.2. Effect of nutrient management

The nutrient management had significant effect on total baby corn yield including all the pickings. Significantly higher baby corn yield was recorded with 100% RDF at 1st picking that was found statistically similar to 75% RDF + 25% VC. Application of 50% RDF +50% VC recorded significantly higher baby corn yield than 100% VC. At 2nd and 5th pick, same trend was followed except that 75% RDF + 25% VC recorded highest baby corn yield and 100% RDF remained statistically at par with it. At 3rd pick, the baby corn yield was again recorded significantly higher at 75% RDF + 25% VC followed by 100% RDF and 50% RDF + 50% VC. The application of 100% VC was found statistically equal to 50% RDF +50% VC but significantly higher than control. At 4th pick, 75% RDF + 25% VC produced significantly highest baby corn yield that was statistically similar to 100% RDF while 50% RDF +50% VC and 100% VC gave significantly higher baby corn yield than control but both the treatments were statistically similar to each other. The total baby corn yield was recorded significantly highest at 75% RDF + 25% VC followed by 100% RDF, 50% RDF +50% VC, 100% VC and control, with 3, 13.0, 25.0 and 60.0% higher value, respectively. Similarly, baby corn yield was increased nearly by 58.6, and 46.3% higher under 100% RDF and 100% VC, respectively than control. The higher baby corn yield was the result of higher baby cob yield. The interaction effect was found non-significant except at 1st picking. The percent production of baby corn under different

Table 4.9. Effect of establishment method and nutrient management on baby corn yield and green fodder yield

Treatment	Baby corn yield (kg/ha)						Green fodder yield (q/ha)
	1st pick	2nd pick	3rd pick	4th pick	5th pick	Total	
A) Establishment methods							
Flat	148 (11.98%)	280 (22.67%)	380 (30.77%)	279 (22.59%)	147 (11.90%)	1235	155
*Flat + Earthing	160 (11.93%)	304 (22.67%)	419 (31.24%)	291 (21.70%)	167 (12.45%)	1341	168
Ridge	172 (11.95%)	324 (22.50%)	452 (31.39%)	318 (22.08%)	174 (12.08%)	1440	180
SEm $\pm$	03	05	11	07	03	11	03
CD (P=0.05)	10	22	43	30	11	44	12
B) Nutrient management							
Control	52 (7.71%)	90 (13.35%)	226 (33.53%)	206 (30.56%)	100 (14.83%)	674	84
100% VC @ 10 t/ha	130 (10.35%)	258 (20.54%)	421 (33.52%)	292 (23.25%)	155 (12.34%)	1256	160
100 % RDF	222 (13.61%)	398 (24.42%)	487 (29.88%)	333 (20.43%)	190 (11.66%)	1630	203
50% RDF+ 50% VC	181 (12.41%)	358 (24.56%)	445 (30.52%)	305 (20.92%)	169 (11.59%)	1458	183
75% RDF + 25% VC	216 (12.81%)	410 (24.31%)	517 (30.66%)	344 (20.40%)	200 (11.86%)	1686	210
SEm $\pm$	03	09	09	08	04	15	02
CD (P= 0.05)	08	25	28	23	13	45	06

***Flat + earthing = Flat followed by earthing**

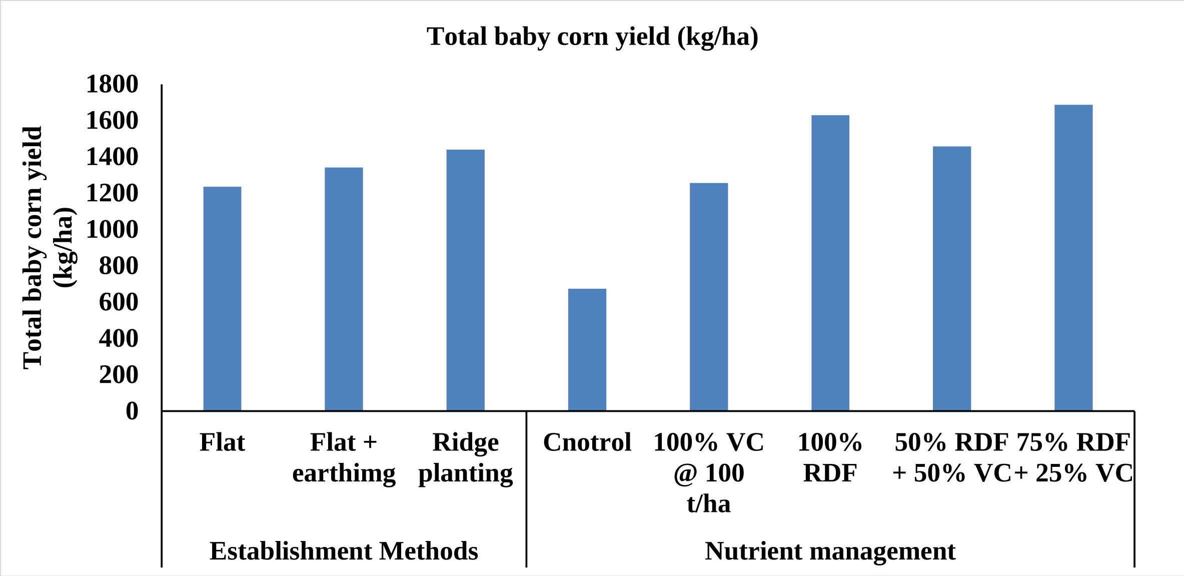


Fig. 4.2. Effect of establishment method and nutrient management on baby corn yield

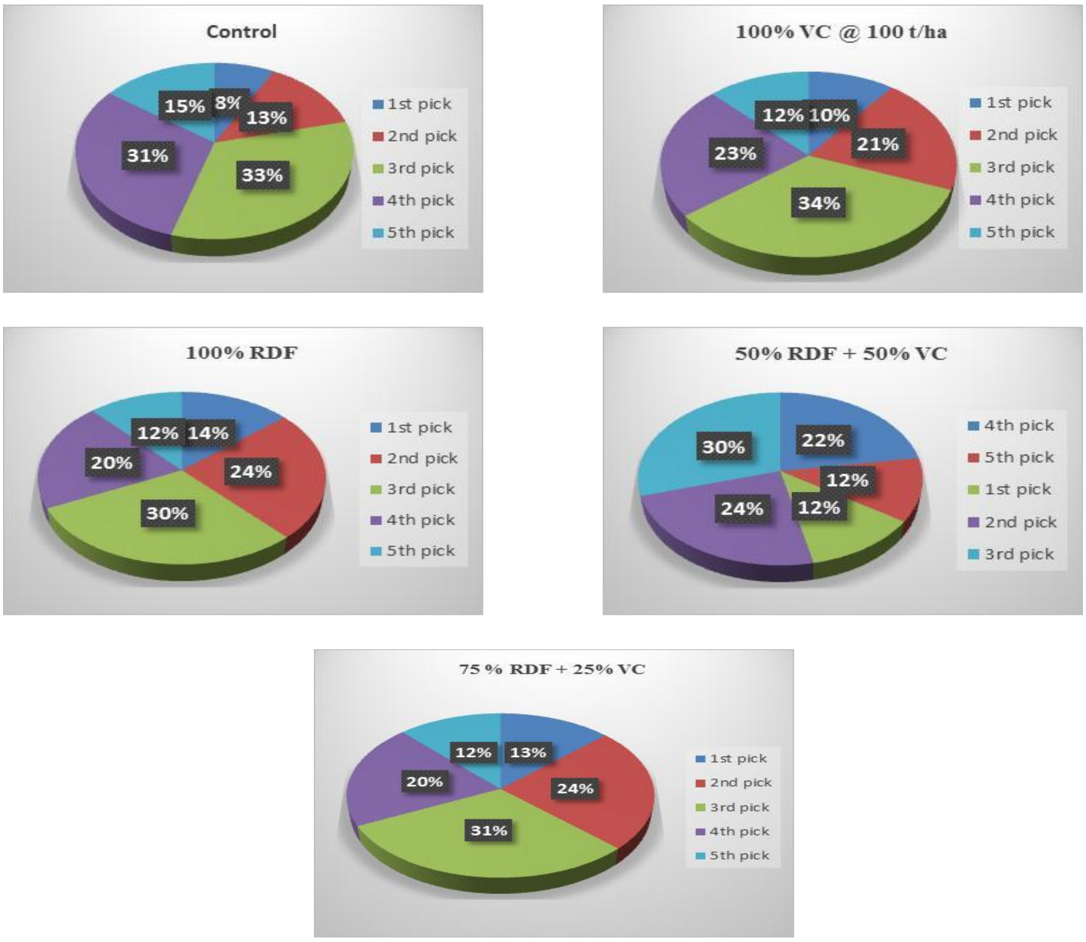


Fig. 4.3. Effect of nutrient management on percent contribution of baby corn under different pickings

pickings varied greatly by different nutrient management options. The 100% RDF and control as well as 100% VC had the higher and the lower contribution of total baby corn production at initial pickings, respectively, while the percent contribution at 3rd and 4th picking was recorded higher under both control and 100% VC compared to other nutrient management strategies possibly due to chemical fertilizers release available form of nutrients quickly but the nutrient availability from organics remain slow in early crop growth stage and later it increased with advancement of mineralization. The chemical coupled with organics had almost similar trend in percent contribution to total baby corn production at different pickings mainly due to uniform availability of nutrients during crop growth period (Fig. 4.3).

4.3.3. Green fodder yield

The establishment methods and nutrient management options had significant influence on green fodder yield (Table 4.9 and appendix XV).

4.3.3.1. Effect of establishment method

The significantly highest green fodder yield was recorded at ridge planting followed by flat + earthing and significantly lowest under flat planting. Ridge planting produced 7.5 and 16% higher green fodder than flat + earthing and flat method, respectively. Similarly, flat + earthing produced 7.9% higher green fodder than flat planting method. The variation in green fodder yield was caused due to difference in plant population, plant height and LAI.

4.2.2.2. Effect of nutrient management

The green fodder yield was recorded significantly highest at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC and 100% VC, respectively. Control produced significantly lowest green fodder yield. On an average, application of 75% RDF + 25% VC produced 3, 13 and 23% higher green fodder yield than 100% RDF, 50% RDF + 50% VC and 100% VC, respectively. The yield increment at 100% RDF and 100% VC over control gave nearly same values as in case of baby cob yield. The higher green fodder yield was attributed to better plant growth. The interaction effect between establishment methods and nutrient management was found non-significant.

4.4. Quality parameter

4.4.1. Total soluble solids

The TSS was measured with the help of hand refractometer and its value increased gradually up to 4th picking and then decreased. The establishment methods and nutrient management options had significant effect on TSS except establishment method at 4th and 5th picking (Table 4.10 and appendix XVI)

Table 4.10. Effect of establishment method and nutrient management on total soluble solids (TSS) of baby corn

Treatment	TSS (%)					
	1st pick	2nd pick	3rd pick	4th pick	5th pick	Average
A) Establishment method						
Flat	7.8	8.1	9.1	10.1	9.3	8.9
*Flat + Earthing	8.1	8.4	9.3	10.2	9.4	9.1
Ridge	8.2	8.5	9.4	10.3	9.5	9.2
SEm ±	0.07	0.07	0.02	0.06	0.05	0.03
CD (P=0.05)	0.3	0.3	0.2	NS	NS	0.1
B) Nutrient management						
Control	7.6	7.7	8.5	9.2	7.7	8.1
100% VC @ 10 t/ha	8.0	8.4	9.3	10.1	9.7	9.1
100% RDF	8.3	8.6	9.5	10.6	9.9	9.4
50% RDF+ 50% VC	8.1	8.5	9.4	10.3	9.8	9.2
75% RDF + 25% VC	8.2	8.7	9.6	10.7	10.1	9.5
SEm ±	0.14	0.10	0.2	0.16	0.12	0.06
CD (P= 0.05)	0.4	0.3	0.3	0.5	0.3	0.2

***Flat + earthing = Flat followed by earthing**

4.4.1.1. Effect of establishment method

Significantly highest TSS was recorded under ridge planting than flat method but it was statistically at par with flat + earthing at all the pickings except at 4th and 5th picking where all the establishment methods were found non-significant with each other. On an average, significantly higher TSS was recorded under ridge planting that was statistically equal to flat + earthing method. The lowest TSS was recorded at flat planting method. Higher TSS under ridge planting was caused due to better soil conditions for growth and development resulting higher formation of phtotosynthates. **Painyuli (2010)** also reported higher TSS of sweet corn under ridge planting.

4.4.1.2. Effect of nutrient management

The TSS was recorded significantly highest at 75% RDF + 25% VC that was significantly similar to 100 % RDF and 50% RDF + 50% VC and 100% VC at all the pickings except at 1st pick where 100% RDF recorded the highest TSS. The application of 100% VC at 2nd, 3rd 4th and 5th picking recorded significantly higher TSS than control that was statistically similar to 100% RDF and 50% RDF + 50% VC however at 1st pick application of 100% VC produced similar TSS as control. The average TSS recorded significantly higher at 75% RDF + 25% VC than 50% RDF + 50% VC, 100% VC and control but was non-significant with 100% RDF. The application of 50% RDF + 50% VC had recorded significantly similar TSS with 100% VC. **Dalvi et al. (2009)** also reported increased TSS of sweet corn at INM. The interaction between establishment methods and nutrient management strategies was found non-significant except at 3rd picking.

4.4.2. Nitrogen content

The nitrogen content of baby corn was increased progressively up to 4th pick, however it varied significantly among different establishment methods and nutrient management approaches (Table. 4.11, fig. 5 and appendix XVII)

4.4.2.1. Effect of establishment method

The highest nitrogen content was recorded under ridge planting followed by flat + earthing at all the pickings except at 5th pick where both planting methods had equal values, however, significantly lowest N content was estimated under flat method at all the pickings except at 3rd pick, where it remained statistically similar to flat+ earthing. On an average values, ridge planting had significantly highest N content compared to flat method but it showed non-significant effect with flat+ earthing. Higher nitrogen content was might be due to better soil physical conditions favouring higher nutrient uptake. These results are in close agreement with the results reported by **Painyuli (2010).**

4.4.2.2. Effect of nutrient management

At 1st pick, 100% RDF recorded significantly higher nitrogen content that was statistically at par with 75% RDF + 25% VC and significantly lowest N content was found at control followed by 100% VC and 50% RDF + 50% VC. However, at 2nd picking and on an average values, 100% RDF and 75% RDF + 25% VC had significantly higher nitrogen content with equal values followed by 50% RDF + 50% VC, 100% VC and control. At 3rd and 4th picking, the highest nitrogen content was recorded with application of 75% RDF + 25% VC than 100% RDF and control recorded the lowest N content followed by 50% RDF + 50% VC and 100% VC. At 5th pick, again 100% RDF and 75% RDF + 25% VC had significantly higher N content than 50% RDF + 50% VC and 100% VC was found non-significant with 50% RDF + 50% VC but significantly higher than control, respectively. The total nitrogen content followed the same trend as in 1st picking. The increased N content under INM was caused due to solublization of nutrients in root zone by the release of organic acids from decaying vermicompost. **Pinjari (2009)** also reported significantly higher nutrient content in maize grain at 75% RDN + 25% poultry manure. The interaction was found non–significant between the planting methods and nutrient management options.

4.4.3. Protein content

The establishment methods and nutrient management strategies had significant effect on protein content of baby corn at all the pickings and it increased up to 4th picking. (Table. 4.11, fig. 5 and appendix. XVIII)

4.4.3.1. Effect of establishment method

At 1st and 2nd pick, significantly highest protein content was recorded under ridge planting followed by flat + earthing and lowest under flat method, however, at 3rd, 4th and 5th picking, ridge method was found at par with flat + earthing but significantly higher than

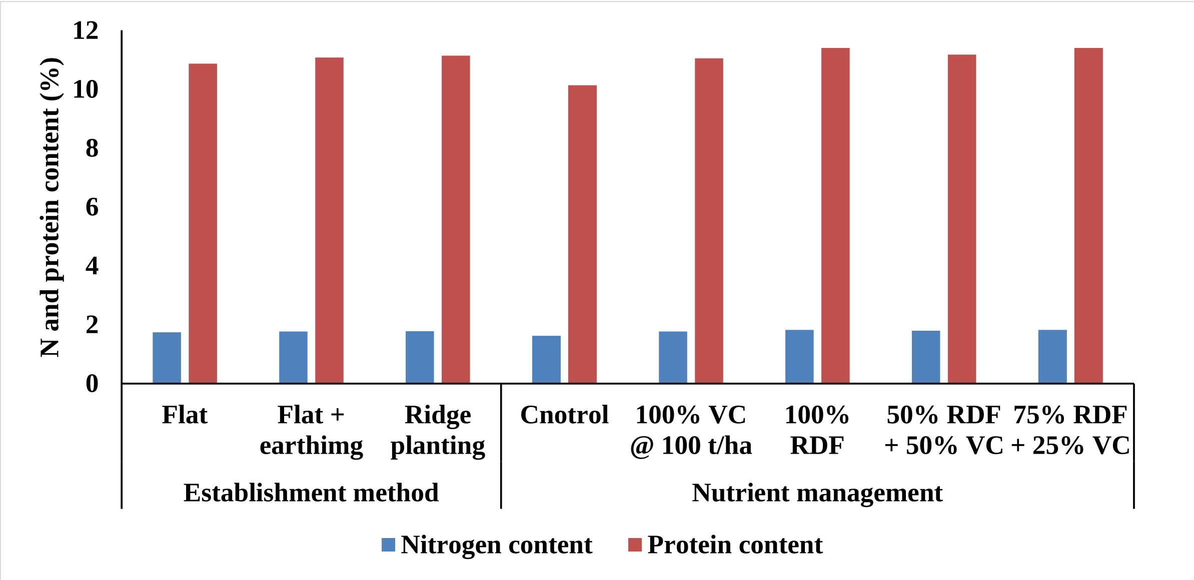


Fig. 4.4. Effect of establishment method and nutrient management on nitrogen and protein content of baby corn

Table.4.11. Effect of establishment method and nutrient management on nitrogen and protein content at different picking stages of baby corn

Treatment	N content (%)						Protein content (%)					
	1st pick	2nd pick	3rd pick	4th pick	5th pick	Average	1st pick	2nd pick	3rd pick	4th pick	5th pick	Average
A) Establishment method												
Flat	1.45	1.80	1.82	1.83	1.80	1.74	9.06	11.26	11.36	11.41	11.26	10.87
*Flat + Earthing	1.49	1.85	1.84	1.85	1.84	1.77	9.29	11.55	11.53	11.58	11.48	11.08
Ridge	1.50	1.86	1.85	1.86	1.84	1.78	9.36	11.63	11.56	11.63	11.53	11.14
SEm ±	0.002	0.003	0.004	0.002	0.005	0.001	0.001	0.02	0.02	0.01	0.03	0.004
CD (P=0.05)	0.01	0.01	0.02	0.01	0.02	0.01	0.05	0.07	0.10	0.06	0.13	0.02
B) Nutrient management												
Control	1.33	1.63	1.72	1.73	1.70	1.62	8.33	10.17	10.73	10.83	10.60	10.13
100% VC @ 10 t/ha	1.48	1.84	1.84	1.85	1.82	1.77	9.23	11.51	11.53	11.58	11.39	11.05
100% RDF	1.54	1.91	1.88	1.89	1.89	1.82	9.59	11.96	11.81	11.83	11.80	11.40
50% RDF+ 50% VC	1.51	1.89	1.85	1.86	1.84	1.79	9.47	11.81	11.54	11.60	11.52	11.18
75% RDF + 25% VC	1.53	1.91	1.89	1.90	1.89	1.82	9.57	11.95	11.82	11.85	11.80	11.40
SEm ±	0.005	0.005	0.005	0.006	0.006	0.003	0.03	0.03	0.03	0.04	0.04	0.02
CD (P= 0.05)	0.02	0.01	0.02	0.02	0.02	0.01	0.10	0.09	0.09	0.11	0.12	0.06

***Flat + earthing = Flat followed by earthing**

flat method. On an average values, ridge planting had significantly higher protein content than flat + earthing and flat method with 0.54 and 2.4% higher values, respectively. Similarly, baby corn planted at flat + earthing produced 2% higher protein content than flat method, respectively. The higher protein content was caused due to increased nitrogen content in baby corn. **Rasheed *et al.* (2003)** also reported higher protein content in maize at ridge planting.

4.4.3.2. Effect of nutrient management

At 1st and 2nd picking, significantly highest protein content was recorded at 100% RDF followed by 50% RDF + 50% VC, 100% VC and control that was significantly equal to 75% RDF + 25% VC. However, at 3rd and 4th pick, 75% RDF + 25% VC had significantly higher protein content than other treatments but it was found at par with 100% RDF and 100% VC was found non-significant with 50% RDF + 50% VC. At 5th pick and on an average values, 75% RDF + 25% VC and 100% RDF had significantly equal values that was statistically higher than other treatments. Significantly lowest protein content was noticed at control at all the pickings. The application of both 100% RDF and 75% RDF + 25% VC recorded 1.9, 3.11 and 12.5% higher protein content than 50% RDF + 50% VC, 100% VC and control, respectively. Similarly, 100% VC recorded 9% higher protein content than control. The higher availability of nutrients and increased nitrogen content under INM resulted in increased protein content. The interaction was found non-significant.

4.5 Nutrient content in baby corn and green fodder

The data pertaining to N, P and K content in baby corn and green fodder is given in table 4.12 and appendix. XIX. The establishment methods and nutrient management had significant effect on N and P content in baby corn but in fodder only P content differed significantly by establishment methods.

4.5.1 N content

4.5.1. Effect of establishment method

The effect of establishment methods on N content in baby corn was found significant while in green fodder, it was non-significant. In baby corn, N content was recorded significantly highest under ridge method and lowest at flat method. In green fodder, though N content was not significantly affected by establishment methods but numerically higher N content was found in ridge planting i.e. 4.72% than flat method.

Jassal (2013) also reported non-significant effect on planting method in maize stover with respect to N content. The higher nitrogen content under ridge and flat + earthing might be due to soil manipulation which would have resulted in reduced leaching of nitrogen and more uptake.

Table 4.12. Effect of establishment method and nutrient management on N, P and K content in baby corn and green fodder

Treatment	N content (%)		P content (%)		K content (%)	
	Corn	Green fodder	Corn	Green fodder	Corn	Green fodder
A) Establishment method						
Flat	1.74	1.27	0.48	0.22	0.72	1.29
*Flat + Earthing	1.77	1.32	0.52	0.29	0.73	1.30
Ridge	1.79	1.33	0.53	0.30	0.74	1.31
SEm ±	0.003	0.02	0.02	0.007	0.01	0.01
CD (P=0.05)	0.01	NS	0.03	0.02	NS	NS
B) Nutrient management						
Control	1.62	1.22	0.36	0.25	0.66	1.23
100% VC @ 10 t/ha	1.77	1.27	0.50	0.26	0.71	1.28
100% RDF	1.82	1.36	0.57	0.29	0.76	1.34
50% RDF+ 50% VC	1.79	1.29	0.52	0.27	0.75	1.32
75% RDF + 25% VC	1.82	1.36	0.57	0.29	0.76	1.34
SEm ±	0.003	0.003	0.007	0.007	0.01	0.012
CD (P= 0.05)	0.01	0.01	0.02	0.02	0.03	0.04

***Flat + earthing = Flat followed by earthing**

4.5.1.2. Effect of nutrient management

Nutrient management practices influenced significantly the N content in baby corn and green fodder. Among different treatments of nutrient management in baby corn and green fodder, 100% RDF and 75% RDF + 25% VC recorded significantly higher N content than 50% RDF + 50% VC and 100% VC but both treatments were statistically similar to each other. Nitrogen content in baby corn and green fodder was 10.9% and 10.2% higher at 100% RDF and 75% RDF + 25% VC, respectively than control. The interaction was found non-significant. Higher nitrogen content was caused due to readily available nitrogen for uptake.

4.5.2. Phosphorus content

4.5.2.1. Effect of establishment method

The P content of baby corn as well as green fodder was influenced significantly by establishment methods. Under different establishment methods, inference can be seen from the data that P content was higher under ridge planting, however it was statistically at par flat+earthing method but significantly higher than flat method in both baby corn and green fodder.

4.5.2.2. Effect of nutrient management

The nutrient management had significant effect on P content in baby corn and green fodder. Among five different nutrient management practices followed in baby corn, P content was found statistically similar under 100% RDF and 75% RDF + 25% VC which was significantly higher than 100% VC and 50% RDF + 50% VC, whereas, the lowest P content was recorded at control. In green fodder, nutrient application i.e. 75% RDF + 25% VC, 100% RDF and 50% RDF + 50% VC were found statistically equal to each other but significantly higher than control. The interaction effect between establishment methods and nutrient management options was found non-significant.

4.5.3. K content

4.5.3.1. Effect of establishment method

K content in baby corn and green fodder was not affected significantly by establishment methods, though the numerically the highest and the lowest K content were found at ridge and flat planting methods, respectively.

4.5.3.2. Effect of nutrient management

The K content of baby corn as well as green fodder was affected significantly by nutrient management and significantly higher K content was recorded at 100% RDF and 75% RDF + 25% VC with equal values but statistically at par to 50% RDF + 50% VC in both, baby corn and green fodder. In baby corn, 50% RDF + 50% VC had significantly higher K content as compared to 100% VC, however, in green fodder it was found significantly similar to 100% VC. The interaction was found non-significant.

4.6. Nutrient uptake

Establishment methods and nutrient management had significant effect on N, P and K uptake in baby corn and green fodder (Table. 4.13 & appendix XX).

Table.4.13. Effect of establishment method and nutrient management on N, P and K uptake in baby corn and green fodder

Treatment	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
	Baby corn	Green fodder	Total	Baby corn	Green fodder	Total	Baby corn	Green fodder	Total
A) Establishment method									
Flat	4.35	158.20	162.55	1.24	27.40	28.64	1.80	160.69	162.50
*Flat + Earthing	4.76	183.78	188.54	1.42	40.06	41.48	1.96	179.60	181.56
Ridge	5.20	194.04	199.24	1.57	43.77	45.34	2.16	191.12	193.28
SEm ±	0.05	2.74	2.80	0.02	0.42	0.48	0.03	2.51	2.63
CD (P=0.05)	0.20	8.64	8.92	0.08	1.23	1.44	0.13	7.42	8.10
B) Nutrient management									
Control	2.21	151.50	153.71	0.50	31.04	31.54	0.91	140.32	141.23
100% VC @ 10 t/ha	4.51	167.97	172.48	1.29	34.38	35.63	1.82	169.29	171.11
100% RDF	5.98	192.45	198.43	1.89	41.04	42.93	2.48	189.62	192.10
50% RDF+ 50% VC	5.18	175.35	180.53	1.51	36.70	38.21	2.16	179.42	181.58
75% RDF + 25% VC	5.97	200.15	206.12	1.88	42.68	44.56	2.47	197.20	199.67
SEm ±	0.08	2.40	2.52	0.03	0.51	0.52	0.05	2.75	2.78
CD (P= 0.05)	0.25	7.31	7.50	0.08	1.53	1.56	0.14	8.30	8.31

***Flat + earthing = Flat followed by earthing**

4.6.1. Nitrogen uptake

4.6.1.1 Effect of establishment method

Significantly higher nitrogen uptake in baby corn, green fodder as well as total was found at ridge planting followed by flat + earthing and flat method, respectively. The higher nitrogen uptake was caused due to higher dry matter production as well as its nitrogen content. **Kaur (2013)** also reported higher nitrogen uptake in grains and stover under ridge planting.

4.6.1.2 Effect of nutrient management

The treatment with application of 100% RDF had significantly higher nitrogen uptake in baby corn that was non-significant with 75% RDF + 25% VC. The 50% RDF + 50% VC had significantly higher nitrogen uptake than 100% VC and significantly lowest at control. In green fodder and total uptake significantly higher nitrogen uptake was recorded at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC, 100% VC and lowest under control. The reason for higher nutrient uptake was due to higher yield and nutrient contents. **Reddy *et al.* (2016)** also reported higher nutrient uptake at 75% recommended dose of nitrogen + 25% vermicompost.

4.6.2 Phosphorus uptake

4.6.2.1 Effect of establishment method

P uptake in baby corn and green fodder was influenced significantly by establishment methods and significantly highest P uptake was recorded at ridge planting and lowest under flat planting. P uptake in green fodder and total was recorded significantly higher at ridge planting but it was non-significant with flat + earthing.

4.6.2.2 Effect of nutrient management

The P uptake was influenced significantly by nutrient management and significantly highest P uptake in baby corn was recorded at 100% RDF that remained statistically similar to 75% RDF + 25% VC. However, in green fodder and in total, 75% RDF + 25% VC had significantly higher P uptake but significantly equal to 100% RDF. Application of 50% RDF + 50% VC recorded significantly higher P uptake than 100% VC in baby corn, green fodder and in total. The significantly lowest P uptake was recorded at control.

4.6.3 Potassium uptake

4.6.3.1 Effect of establishment method

The significantly higher K uptake in baby corn, green fodder and in total was recorded at ridge planting followed by flat + earthing and flat method, respectively. The higher K uptake was the result of higher plant population, dry matter accumulation and yield.

4.6.3.2 Effect of nutrient management

Nutrient management had significant influence on K uptake and significantly higher K uptake in baby corn was recorded at 100% RDF that was statistically similar to 75% RDF + 25% VC. The 50% RDF + 50% VC had significantly higher potassium uptake than 100% VC and significantly lowest at control. The potassium uptake of green fodder was recorded significantly higher at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC, 100% VC and control, respectively. Total potassium uptake also followed the same trend as green fodder except that 100% RDF had statically equal potassium uptake with 75% RDF + 25% VC. **Reddy *et al.* (2016)** also reported higher N, P and K content and uptake with the application of 75% nitrogenous fertilizer and 25% vermicompost. The higher nutrient uptake was caused due to higher dry matter, plant population and nutrient content.

4.7 Soil nutrient studies

The soil nutrient status i.e. organic carbon, available nitrogen, phosphorus and potassium was influenced significantly by establishment methods and nutrient management options after harvesting of the crop except organic carbon by establishment methods (Table 4.14 and appendix XXI)

4.7.1 Organic carbon

4.7.1.1 Effect of establishment method

The establishment methods had non-significant effect on soil organic carbon however, higher value was found under flat planting followed by flat + earthing and ridge method. The lower organic carbon at ridge planting might be due to increased aeration that resulted in higher breakdown of organic matter.

4.7.1.2 Effect of nutrient management

The organic carbon was recorded significantly highest at 100% VC that remained statistically equal to 50% RDF + 50% VC. The lowest organic carbon was measured at control that was non-significant with 75% RDF + 25% VC and 100% RDF but both the treatments had higher organic carbon than control. The application of vermicompost increased organic carbon as it contains more organic material.

4.7.2 Available nitrogen

4.7.2.1 Effect of establishment method

The highest available N was recorded at flat planting followed by flat + earthing and lowest under ridge planting. The lower available nitrogen in soil at ridge planting was due to better soil physical condition that resulted in higher nutrient uptake in plants.

Table 4.14. Effect of establishment method and nutrient management on soil organic carbon, available nitrogen, phosphorus and potassium in soil after crop harvest

Treatment	Organic carbon (%)	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
A) Establishment methods				
Flat	1.00	284.29	30.49	240.07
*Flat + Earthing	0.98	281.99	29.33	237.51
Ridge	0.97	279.90	28.59	236.75
SEm$\pm$	0.02	0.35	0.18	0.22
CD (P=0.05)	NS	1.40	0.73	0.96
B) Nutrient management				
Control	0.90	270.74	22.06	218.43
100% VC @ 10 t/ha	1.06	293.34	35.30	256.18
100% RDF	0.95	275.08	26.92	231.19
50% RDF+ 50% VC	1.04	287.98	32.21	244.58
75% RDF + 25% VC	0.97	283.14	30.86	240.18
SEm$\pm$	0.03	1.04	0.58	1.11
CD (P= 0.05)	0.08	3.05	1.72	3.25

***Flat + earthing = Flat followed by earthing**

4.7.2.2 Effect of nutrient management

The significantly higher available nitrogen was recorded at 100% VC followed by 50% RDF + 50% VC, 75% RDF + 25% VC and 100% RDF, respectively. The significantly lowest value was found at control. The increased available nitrogen at vermicompost applied plots was caused due to more production of mineralized NO_3-N. These findings are in close conformity as obtained by **Saha *et al.* (2008).**

4.7.3 Available phosphorus

4.7.3.1 Effect of establishment methods

The flat planting had significantly highest available phosphorus followed by flat + earthing and ridge planting, respectively. The higher available phosphorus at flat planting was caused due to unfavorable condition for nutrient uptake.

4.7.3.2 Effect of nutrient management

The application of 100% VC recorded highest available phosphorus followed by 50% RDF + 50% VC, 75% RDF + 25% VC, 100% RDF and control, respectively. The higher available phosphorus at application of organics was caused due to production of organic acids that resulted in conversion of fixed phosphorus into available form.

4.7.4 Available potassium

4.7.4.1 Effect of establishment method

The establishment method had significant effect on available potassium and significantly highest value was recorded at flat planting than flat + earthing and ridge method, however ridge and flat + earthing was found statistically at par with each other. **Kaur (2016)** also reported available higher available nitrogen, phosphorus and potassium balance in soil under flat planting than ridge method of planting.

4.7.4.2 Effect of nutrient management

The soil available potassium after the harvesting of crop was increased in the vermicompost applied treatments. The significantly highest available potassium was recorded at 100% VC followed by 50% RDF + 50% VC, 75% RDF + 25% VC and 100% RDF. The lowest value was observed at control. The nutrient builds up at vermicompost applied plots was due to enriched nutrient content and beneficial microbes in vermicompost. The interaction between establishment methods and nutrient management options was found non-significant.

4.7.5 Apparent nutrient balance

The apparent nutrient balance of soil after crop harvest has been shown in table 4.15.

Table. 4.15. Effect of establishment method and nutrient management on apparent nutrient balance in soil after crop harvest

Treatment	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
A) Establishment method			
Flat	1.78	2.37	5.07
*Flat + Earthing	-0.523	1.21	2.51
Ridge	-2.61	0.47	1.75
SEm±	-	-	-
CD (P=0.05)	-	-	-
B) Nutrient management			
Control	-11.76	-6.06	-16.57
100 % VC @ 10 t/ha	10.84	7.18	21.18
100 % RDF	-7.43	-1.20	-.3.81
50 % RDF+ 50% VC	5.47	4.09	9.58
75 % RDF + 25 % VC	0.63	2.74	5.18
SEm±	-	-	-
CD (P= 0.05)	-	-	-

***Flat + earthing = Flat followed by earthing**

4.7.5.1 Effect of establishment method

The highest nitrogen, phosphorus and potassium balance was recorded at flat planting followed by flat + earthing and flat method, respectively. The positive nutrient balance was found in case of phosphorus and potassium under all establishment methods, however flat + earthing and ridge method recorded negative apparent nitrogen balance. The higher apparent nutrient balance under flat method was caused due to least nutrient uptake in plants.

4.7.5.2 Effect of nutrient management

The highest apparent nitrogen, phosphorus and potassium balance was recorded at 100% VC followed by 50% RDF + 50% VC, 75% RDF+ 25% VC, 100% RDF and lowest at control. The 100% RDF and control had negative apparent nutrient balance. The higher nutrient balance under organics and INM might be due to either mobilization of nutrients through the production of organic acids or addition of residual nutrient in the soil.

4.8 Soil microbial studies

Soil microbial population i.e. bacteria, fungi and actinomycets was recorded after crop harvest and it’s a good indicator of soil health. The establishment methods and nutrient management had significant influence on soil microbial population (Table 4.16, plate 2. and appendix XXII).

4.8.1 Bacterial population

4.8.1.1 Effect of establishment method

The significantly highest bacterial count in soil was recorded at ridge planting that was statistically at par with flat + earthing and significantly lowest under flat method. The higher bacterial population was caused due to well aerated conditions that promoted growth of aerobic bacteria in soil. **Hemmat and Eskandari (2004)** also reported higher bacterial count at raised bed planting than flat planting due to proper aeration.

4.8.1.2 Effect of nutrient management

The bacterial count was influenced significantly by nutrient management options and the significantly highest bacterial count was recorded at 100% VC followed by 50% RDF + 50% VC. The 75% RDF +25% VC and 100% RDF had significantly higher bacterial count than control but remained non-significant with each other. The substitution of chemical fertilizer with vermicompost resulted in more bacterial count in soil possibly due to more bacterial population on vermicompost and vermicast. **Khan *et al.* (2017)** also reported higher microbial population at INM.

4.8.2 Fungi population

4.8.2.1 Effect of establishment methods

The establishment methods had significant effect on fungi population and significantly higher fungi count was recorded at ridge planting followed by flat + earthing and flat method. Fungi are the aerobic microbes and ridge planting provided more aerated condition in soil that resulted in higher fungi population in soil.

4.8.2.2 Effect of nutrient management

The application of 100% VC recorded significantly highest fungi population in soil, however 50 and 75% substitution of VC with chemical fertilizers had significantly higher fungi count than 100% RDF but remained statistically similar to each other. The lowest count was recorded at unfertilized plots. The fungi are the saprophytic organism and depends on the dead decaying organic matter for their food demand. The addition of vermicompost added organic matter in soil enriched with microbial activity that resulted in higher fungal count in soil.

4.8.3 Actinomycets population

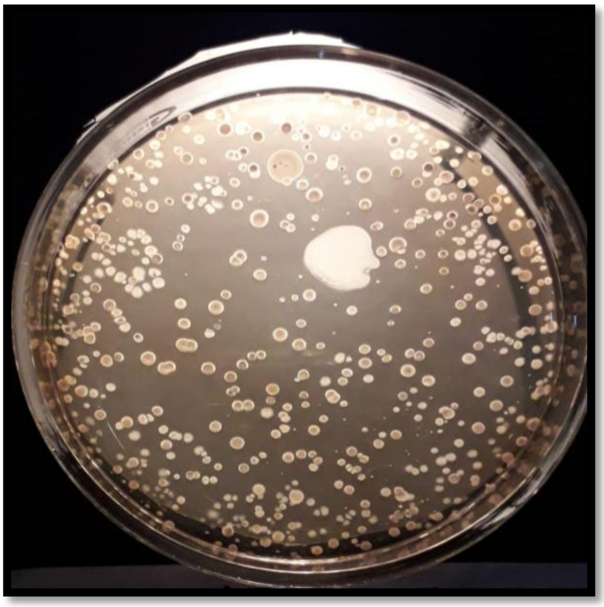
4.8.3.1 Effect of establishment methods

The ridge planting recorded significantly highest actinomycets population that was significantly similar to flat + earthing and lowest at flat method. Actinomycets also required aerobic condition for their survival so highest actinomycets count was recorded at ridge planting.

4.8.3.2 Effect of nutrient management

The actinomycets population was influenced significantly among nutrient management options and significantly highest population was recorded at 100% VC followed by 50% RDF + 50% VC, 75% RDF + 25% VC, 100% RDF and lowest at control. The increasing dose of vermicompost increased the actinomycets population as it consists of organic material along with actinomycets rich microbiota.

The interaction effect was on soil microbial population was found non-significant.



Bacteria

Fungi

Actinomycets

Plate 2. Soil microbial colonies

Table 4.16. Effect of establishment method and nutrient management on soil microbial population after crop harvest

Treatment	Soil microbial population		
	Bacteria (cfu × 10^{4})	**Fungi (cfu × 10^{2})**	**Actinomycets (cfu × 10^{4})**
A) Establishment method			
Flat	4.33	4.12	0.95
*Flat + Earthing	5.07	4.50	1.15
Ridge	5.33	5.27	1.23
SEm$\pm$	0.15	0.26	0.40
CD (P=0.05)	0.62	0.30	0.14
B) Nutrient management			
Control	2.67	2.56	0.41
100% VC @ 10 t/ha	7.67	7.06	2.00
100% RDF	3.22	2.87	0.44
50% RDF+ 50% VC	6.22	5.60	1.50
75% RDF + 25% VC	4.78	5.08	1.18
SEm$\pm$	0.40	0.26	0.03
CD (P= 0.05)	1.17	0.76	0.08

***Flat + earthing = Flat followed by earthing**

4.9 Economics

The establishment methods and nutrient management options had significant influence on gross return, net return, B:C ratio and net profit per day (Table 4.17 and appendix XXIII).

4.9.1 Effect of establishment method

The ridge planting had significantly highest gross return, net return, B:C ratio and net profit per day followed by flat + earthing and significantly lowest at flat method. The ridge planting gave 8.1% and 16.4% higher gross return and 11.7% and 24.6% higher net return than flat + earthing and flat method, respectively. Similarly, flat + earthing produced 7.6% and 11.5% higher gross and return than flat method, respectively. The higher net income and B:C ratio at ridge planting resulted in generation of higher net profit per day i.e. Rs 286/- and Rs 151/- higher than flat and flat + earthing method, respectively.

4.9.2 Effect of nutrient management

The significantly higher gross return was found at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC, 100% VC and control, respectively.

The application of 75% RDF + 25% VC and 100% RDF recorded 34.4 and 27.8% higher gross return than 100% VC, respectively. Similarly, gross return was increased nearly by 88 and 141% higher at 100% VC and 100% RDF, respectively than control.

The application of 100% RDF recorded significantly highest net return that was statistically at par with 75% RDF + 25% VC. The net profit realization from 100% VC and control was found significantly similar but significantly lower than 50% RDF + 50% VC. The 100% RDF generated 3.1, 32 and 64% higher net return than 75% RDF + 25% VC, 50% RDF + 50% VC and 100% VC, respectively. Application of 100% VC and 100% RDF produced 6.1 and 195% higher net return, respectively than control.

The B:C ratio was recorded significantly highest with application of 100% RDF followed by 75% RDF + 25% VC, control and 50% RDF + 50% VC, respectively. However, 100% VC recorded significantly lowest B:C ratio. The application of

Table 4.17. Effect of establishment methods and nutrient management on gross return, net return, B:C ratio and net profit per day

Treatment	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Net profit/day (Rs)
A) Establishment method					
Flat	37576	109416	69839	3.20	1164
*Flat + Earthing	37636	117774	77918	3.43	1299
Ridge	40276	127325	87048	3.63	1450
SEm±	-	444	440	0.02	07
CD (P=0.05)	-	1790	1773	0.07	30
B) Nutrient management					
Control	19623	59219	39596	3.01	660
100% VC @ 10 t/ha	62856	111650	42027	1.78	700
100% RDF	25723	142778	116954	5.54	1949
50% RDF+ 50%VC	47623	127145	79421	2.67	1324
75% RDF + 25% VC	40312	150068	113344	4.09	1889
SEm±	-	2128	2128	0.06	35
CD (P= 0.05)	-	6249	6249	0.16	104

***Flat + earthing = Flat followed by earthing**

1. Rate of fresh baby corn = Rs. 60 per kg

2. Rate of green fodder = Rs. 300 per q

vermicompost resulted in lower B:C ratio as it's costly than chemical fertilizers and its application increased the cost of production which ultimately reduced the net return.

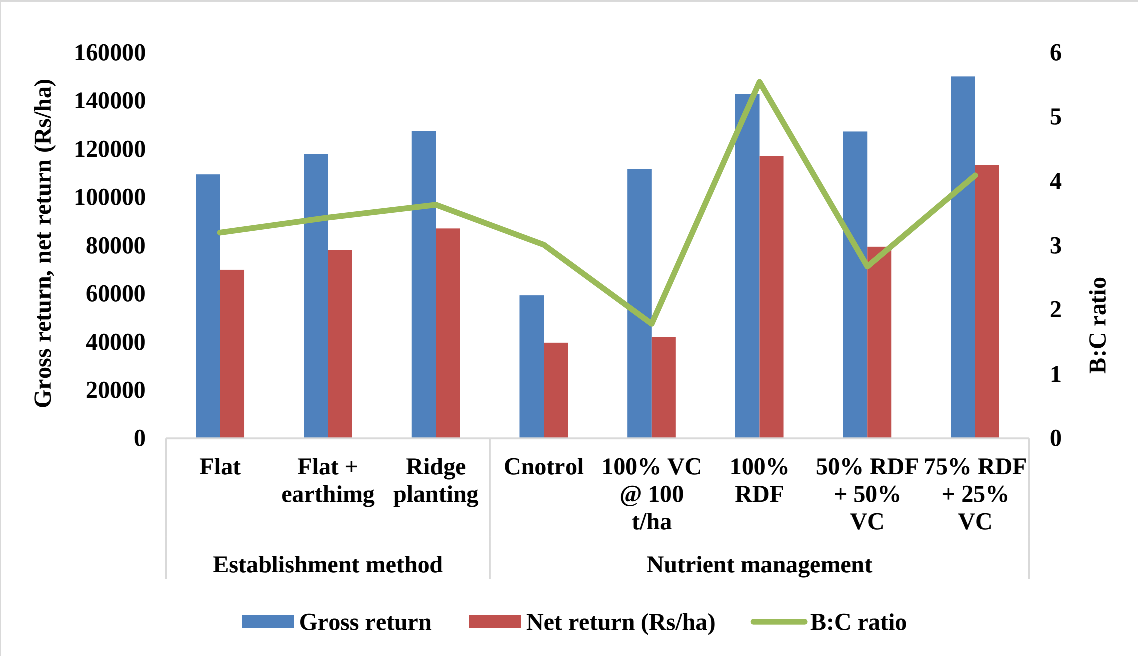


Fig. 4.5. Effect of establishment method and nutrient management on gross return, net return and B:C ratio of baby corn

The application of 100% RDF generated significantly highest net profit per day of Rs 1949/- which is 3, 32 and 64% higher than 75% RDF + 25% VC, 50% RDF + 50% VC and 100% vermicompost respectively. However, the control recorded lowest net profit of Rs 660 per day. The higher values of gross return, net return and B:C ratio was caused due higher baby corn and fodder yield along with lower cost of production. **Nagvani Aand Subbian (2014)** and **Kumar *et al.* (2005)** also reported higher net return per hectare and B:C ratio at 100% RDF than INM treatments.

Summary & Conclusion

CHAPTER-5 SUMMARY AND CONCLUSION

The results based on the field experiment are summarized and concluded as follows;

A. Effect of establishment method

- The ridge planting had highest plant population and lowest mortality percentage.
- Tallest plants were recorded at ridge planting that was remained significantly similar to flat + earthing.
- Ridge planned baby corn produced significantly higher dry matter per plant than other methods at all the growth stages except at 25 DAS where it was found non-significant with flat + earthing.
- Significantly higher leaf area index was noticed at all the growth stages under ridge planting, however, flat and flat + earthing was statistically at par to each other.
- SPAD reading was influenced significantly by establishment methods and significantly highest reading was recorded at ridge planting followed by flat + earthing and flat method, respectively.
- Ridge planted crop had significantly higher at $\overline{CGR}$ 25-45 DAS while at 45 DAS – harvest, numerically highest $\overline{CGR}$ was recorded in flat planted crop.
- $\overline{RGR}$ was recorded significantly highest at 25-45 DAS under ridge planting and flat + earthing with equal values.
- The maximum and minimum days to 50% tasseling was taken by flat and ridge methods, respectively.
- The baby corn length was not differed significantly with establishment methods, however ridge planted crop recorded maximum baby corn length.
- Establishment methods had non-significant effect on baby corn diameter but the highest baby corn diameter was measured at flat planting.
- Significantly highest baby cob yield was recorded under ridge planting followed by flat + earthing and flat method. Ridge planting produced 7 and 16.5% higher baby cob yield than flat + earthing and flat planting, respectively.

- Similar trend of percent contribution to total baby corn production was observed under different establishment methods.
- The green fodder yield was found highest at ridge planting.
- TSS of baby corn differed with establishment methods and significant values at 1st, 2nd, 3rd pick and on average values. The significantly highest TSS was recorded at ridge planting that was significantly similar to flat+ earthing.
- Significantly highest protein content was recorded at ridge planting followed by flat + earthing and flat method, respectively.
- Establishment methods had significant effect on N and P content but in green fodder only P content differed significantly. The highest and the lowest N, P and K content was recorded at ridge and flat method, respectively.
- The N, P and K uptake in baby corn and green fodder had greater variation among establishment methods and significantly higher uptake was recorded at ridge planting than flat + earthing and control.
- The different establishment methods had significantly equal organic carbon, however highest numerical value was recorded at flat planting followed by flat + earthing and ridge method, respectively. Significantly highest available N, P and K content was recorded at flat method.
- Highest apparent nutrient balance was recorded at flat method and flat + earthing and ridge planting method recorded the negative apparent nitrogen balance.
- The soil microbial population differed significantly by different establishment methods and significantly highest microbial count was recorded at ridge planning that was statistically at par with flat + earthing except fungi population where flat + earthing recorded significantly lower fungi count than ridge planted crop.
- The ridge planted baby corn recorded significantly highest gross return, net return, B:C ratio and net profit per day with 10 and 20% highest net return than flat + earthing and flat method, respectively.
- Ridge planted baby corn generated Rs 151/- and Rs 286/- more profit per day than flat + earthing and flat method, respectively.

B. Effect of nutrient management

- The plant population and mortality percentage did not influence significantly with different nutrient management.
- Tallest plants were recorded at 75% RDF + 25% VC that was statistically at par with 100% RDF.
- The highest and the lowest baby corn and green fodder dry matter was received from 75% RDF + 25% VC and control, respectively.
- The leaf area index was recorded significantly highest at 75% RDF + 25% VC that remained significantly similar to 100% RDF.
- SPAD values differed significantly by nutrient management strategies and significantly highest reading was recorded at 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC, 100% VC and control, respectively.
- The application of 75% RDF + 25% VC and 100% RDF recorded significantly highest $\overline{\text{CGR}}$ at 25-45 DAS and 45-harvest and found non-significant with application of 50% RDF + 50% VC.
- Significantly highest $\overline{\text{RGR}}$ was recorded at 100% RDF and 75% RDF + 25% VC at 25-45 DAS that was statistically at par with 50% RDF + 50% VC and 100% VC. However at 45 DAS–harvest, $\overline{\text{RGR}}$ values remained non- significant and the highest $\overline{\text{RGR}}$ was recorded at control.
- Significantly longest and lowest days to 50% tasseling were recorded at control and 75% RDF + 25% VC, respectively.
- The length of baby corn differed significantly with nutrient management options and longest baby corn was produced under 100% RDF at 1st,2nd picking and on an average, however, at 3rd, 4th and 5th picking, 75% RDF + 25% VC produced longest baby corn.
- Application of 100% RDF produced higher girth of baby corn at 1st, 2nd, 3rd picking and on an average. However, at 4th and 5th picking, application of 75% RDF + 25% VC recorded highest diameter of baby corn.

- Significantly highest baby cob yield was recorded at 75% RDF + 25% VC at all the pickings that was statistically similar to 100% RDF except at 1st and 3rd picking, where 100% RDF produced significantly higher and significantly lower yield, respectively. The 75% RDF + 25% VC produced 3.5 and 15.6% higher total baby cob yield than 100% RDF and 50% RDF + 50% VC, respectively.
- The baby corn yield was recorded significantly highest at 75% RDF + 25% VC and it had 3, 13, 25 and 60% greater baby corn yield than 100% RDF, 50% RDF + 50% VC, 100% VC and control, respectively.
- The chemical fertilizers either alone or coupled with organics had better share to total baby corn production at early pickings than sole application of organics.
- The green fodder yield was found highest with 75% RDF + 25% VC followed by 100% RDF, 50% RDF + 50% VC, 100% VC and control, respectively.
- Different nutrient management had significant effect on TSS of baby corn and significantly highest TSS was recorded at 75% RDF + 25% VC that was statistically similar to 100% RDF.
- The application of 75% RDF + 25% VC recorded highest protein content that was significantly similar to 100% RDF.
- The N, P and K content of baby corn was influenced significantly by nutrient management and significantly highest nutrient content with similar values was recorded at 100% RDF and 75% RDF + 25% VC.
- The baby corn had highest N and P uptake at 100% RDF, whereas in green fodder 75% RDF + 25% VC recorded highest N and P uptake but in both cases they were found non-significant to each other.
- Application of 100% RDF recorded highest K uptake in baby corn that was statistically at par with 75% RDF + 25% VC but in green fodder, 75% RDF + 25% VC had significantly higher K uptake than 100% RDF.
- The organic carbon in soil was significantly affected by nutrient management practices with the highest value at 100% VC that remained non-significant with 50% RDF + 50% VC.

- Significantly highest available nitrogen, phosphorus and potassium was recorded at 100% VC followed by 50% RDF + 50% VC, 75% RDF + 50% VC, 100% RDF and control, respectively.
- Highest apparent nitrogen, phosphorus and potassium balance was recorded at 100% VC and negative apparent nutrient balance was found at control and 100% RDF.
- The soil microbial population differed significantly by different nutrient management options and significantly highest microbial count was found at higher dose of vermicompost i.e. 100% VC.
- Significantly highest gross return was found at 75% RDF + 50% VC followed by 100% RDF, 50% RDF + 50% VC, 100% VC and control, respectively. However, 100% RDF produced significantly highest net return that was significantly similar to 75% RDF + 25% VC.
- The B:C ratio was found significantly highest at 100% RDF and the lowest at 100% VC.

Conclusion

The experimental results indicate that application of 100% RDF gave significantly highest B:C ratio but the total baby corn yield, gross return and soil health were recorded higher at application of 75% RDF + 25% VC than 100% RDF. It is therefore concluded that baby corn may be grown on ridges with application of 75% RDF + 25% VC for higher productivity, profitability and sustainability of the system in *Tarai* region of Uttarakhand. However, it requires more field experimentation for validation of the results.

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Appendices

APPENDIX - 1

Weekly meteorological parameters during the experiment period (June to August, 2018)

STATION NAME : PANTNAGAR LONGITUDE :79 deg.30' E

LATITUD : 29 deg. N ALTITUDE :343.84m. AMSL

Month	Date	Metro week No. (2018)	Temperature (^{O}C)		Relative Humidity (%)		Rainfall (mm)	No. of rainy days	Sun Shine Hrs.	Wind velocity (km/hr)	Evap. (mm)
			Max	Min.	0712 am	1412 pm					
May-Jun	28-03	22	35.5	23.0	69.7	55.4	38.4	3	7.1	9.6	8.3
June	04-10	23	35.1	26.0	82.1	63.7	87.6	2	7.7	7.5	8
June	11-17	24	34.6	26.2	84.9	63.1	42.8	2	5.2	5	5.7
June	18-24	25	37.2	26.1	76.4	44.7	0	0	7.9	6	6.8
June-July	25-.1	26	35.9	26.6	80.7	67.7	18.2	1	6.4	7.5	7.3
July	02-08	27	32.6	25.4	90.0	70.0	18.0	3	6	3.5	5.6
July	09-15	28	32.5	26.0	88.0	78.4	173.2	3	3.1	6.1	4.2
July	16-22	29	33.3	26.9	82.1	73.1	79.6	2	6.7	3.7	6.6
July	23-29	30	31.2	25.7	91.0	80.0	169	4	2.2	5.6	4.6
July-Aug.	30-05	31	29.7	24.1	93.6	84.0	218.1	6	1	2.2	3.5
Aug.	06-12	32	30.9	24.9	90.4	79.7	126.4	3	3.6	2.6	4.3
Aug.	13-19	33	31.9	26.1	89.0	71.7	73.4	1	4	1.5	3.3
Aug.	20-26	34	30.9	25.5	95.1	83.0	160.8	5	3.2	1.1	4.4
Aug.-Sept	27-02	35	30.7	25.5	92.4	81.0	86.8	3	2	3.3	2.7
Sep	03-09	36	32.3	25.3	90.4	76.3	76.6	2	4.7	5.3	3.9

APPENDIX II

Analysis of variance for plant population of baby corn

Source of variation	d.f.	Mean sum of squares	
		Initial	Harvest
Replication	2	3.47	0.0018
Establishment method(E)	2	32.7	66.237*
Error	4	0.96	0.128
Nutrient management (N)	4	5.13	5.912
E×N	8	0.056	0.017
Error	24	0.252	0.087
Total	44		

***Significant at 5% level of significance**

APPENDIX III

Analysis of variance for mortality % of baby corn

Source of variation	d.f.	Mean sum of squares
		Mortality %
Replication	2	1.028
Establishment method(E)	2	5.97*
Error	4	0.729
Nutrient management (N)	4	0.052
E×N	8	0.024
Error	24	0.169
Total	44	

***Significant at 5% level of significance**

APPENDIX IV

Analysis of variance for plant height at different growth stages for baby corn

Source of variation	d.f.	Mean sum of squares		
		25 DAS	45 DAS	Harvest
Replication	2	4.59	30.73	44.99
Establishment method(E)	2	39.015*	264.79*	1,014.39*
Error	4	3.488	1.151	29.448
Nutrient management (N)	4	69.169*	341.537*	5,366.40*
E×N	8	0.273	1.734	40.094
Error	24	8.377	14.729	37.271
Total	44			

***Significant at 5% level of significance**

APPENDIX V

Analysis of variance for dry matter accumulation at different growth stages for baby corn

Source of variation	d.f.	Mean sum of squares		
		25 DAS	45 DAS	Harvest
Replication	2	5.61	25.22	2.5
Establishment method(E)	2	7.625	1,981.98*	999.589*
Error	4	3.951	10.711	17.025
Nutrient management (N)	4	61.557*	251.978*	565.884*
E×N	8	0.236	0.331	0.17
Error	24	5.847	10.643	17.298
Total	44			

***Significant at 5% level of significance**

APPENDIX VI

Analysis of variance for dry matter accumulation of baby corn, green fodder and total

Source of variation	d.f.	Mean sum of squares		
		Baby corn	Green fodder	Total
Replication	2	1675.9	20466	32687
Establishment method(E)	2	6570.12*	17488536*	18155556*
Error	4	96.927	180036	176038
Nutrient management (N)	4	62948.15*	6945661*	8281252*
E×N	8	98.57	3290	3199
Error	24	490.02	165755	164495
Total	44			

***Significant at 5% level of significance**

APPENDIX VII

Analysis of variance for leaf area index at different growth stages for baby corn

Source of variation	d.f.	Mean sum of squares		
		25 DAS	45 DAS	Harvest
Replication	2	-	**0.2035**	**0.0625**
Establishment method(E)	2	0.055*	3.691*	1.068*
Error	4	0.001	0.159	0.103
Nutrient management (N)	4	0.009*	0.143*	0.083*
E×N	8	-	0.005	0.002
Error	24	-	0.079	0.049
Total	44			

***Significant at 5% level of significance**

APPENDIX VIII

Analysis of variance for crop growth rate at different stages of baby corn

Source of variation	d.f.	Mean sum of squares	
		25-45 DAS	45 DAS - harvest
Replication	2	3.459	**24.029**
Establishment method(E)	2	546.027*	93.206
Error	4	7.752	15.538
Nutrient management (N)	4	18.681*	41.331*
E×N	8	0.172	0.239
Error	24	4.976	14.137
Total	44		

***Significant at 5% level of significance**

APPENDIX IX

Analysis of variance for relative growth rate at different stages of baby corn

Source of variation	d.f.	Mean sum of squares	
		25-35 DAS	50 DAS - harvest
Replication	2		
Establishment method(E)	2		
Error	4		
Nutrient management (N)	4		
E×N	8		
Error	24		
Total	44		

***Significant at 5% level of significance**

APPENDIX X

Analysis of variance for SPAD reading and days to 50% tasseling

Source of variation	d.f.	Mean sum of squares	
		SPAD reading	Days to 50% tasseling
Replication	2	0.47	0.261
Establishment method(E)	2	9.76*	8.867*
Error	4	0.072	0.833
Nutrient management (N)	4	44.895*	35.144*
E×N	8	1.088*	0.728
Error	24	0.216	1.033
Total	44		

***Significant at 5% level of significance**

APPENDIX XI

Analysis of variance for length of baby corn at different harvesting stages

Source of variation	d.f.	Mean sum of squares					
		1st pick	2nd pick	3rd pick	4th pick	5th pick	average
Replication	2	0.001	0.238	0.085	0.745	0.1025	0.028
Establishment method(E)	2	0.15	0.161	0.012	0.006	0.005	0.047
Error	4	0.156	0.235	0.105	0.167	0.1	0.008
Nutrient management (N)	4	7.598*	6.993*	2.066*	2.505*	1.625*	3.693*
E×N	8	0.031	0.039	0.004	0.003	0.004	0.006
Error	24	0.266	0.147	0.142	0.163	0.125	0.035
Total	44						

***Significant at 5% level of significance**

APPENDIX XII

Analysis of variance for diameter of baby corn at different harvesting stages

Source of variation	d.f.	Mean sum of squares					
		1st pick	2nd pick	3rd pick	4th pick	5th pick	Average
Replication	2	0.015	0..117	0.417	0.05	0.124	0.113
Establishment method(E)	2	0.003	0.326	0.121	0.056	0.048	0.08
Error	4	0.036	0.11	0.065	0.071	0.191	0.03
Nutrient management (N)	4	0.762*	0.543*	0.456*	0.457*	0.355*	0.477*
E×N	8	0.001	0.045	0.003	0.003	0.003	0.002
Error	24	0.076	0.09	0.083	0.162	0.096	0.019
Total	44						

***Significant at 5% level of significance**

APPENDIX XIII

Analysis of variance for baby cob yield at different harvesting stages

Source of variation	d.f.	Mean sum of squares					
		1st pick	2nd pick	3rd pick	4th pick	5th pick	Total
Replication	2	1317.1	11368.7	62715.1	43884.5	2742.6	21284.6
Establishment method(E)	2	32,116.2*	116673.1*	300,829.7*	87,769.0*	44,168.1*	2,433,992.1*
Error	4	1,490.4	6,926.1	25,641.7	12,562.6	1,716.2	26,808.1
Nutrient management (N)	4	679954*	2551535*	1766673*	407,984*	215,270*	23,246,730*
E×N	8	2,905.2*	2,195.4	8,177.0	2,425.6	3,348.5	19,701.0
Error	24	1,083.0	10,698.2	12,284.7	8,378.0	2,718.9	32,714.8
Total	44						

***Significant at 5% level of significance**

APPENDIX XIV

Analysis of variance for baby corn yield at different harvesting stages

Source of variation	d.f.	Mean sum of squares					
		1st pick	2nd pick	3rd pick	4th pick	5th pick	Total
Replication	2	12.7	64.5	1252.9	595.3	850.5	4103.7
Establishment method(E)	2	1,613.8*	7,714.2*	22,603.2*	6,425.7*	2,496.0*	164,250.9*
Error	4	1.7	783.4	1,643.8	480.8	215.7	2,424.9
Nutrient management (N)	4	44,889.4*	160739.1*	103,606.0*	22,901.6*	12,483.3*	1,409,224.5*
E×N	8	55.1*	568.9	166.47	350.2	474.1	2,464.4
Error	24	23.0	622.6	1,170.5	643.6	318.8	4,685.8
Total	44						

***Significant at 5% level of significance**

APPENDIX XV

Analysis of variance for green fodder yield

Source of variation	d.f.	Mean sum of squares
Replication	2	11.34
Establishment method(E)	2	2,322.83*
Error	4	127.118
Nutrient management (N)	4	23,227.83*
E×N	8	26.4
Error	24	42.373
Total	44	

***Significant at 5% level of significance**

APPENDIX XVI

Analysis of variance for TSS of baby corn at different harvesting stages

Source of variation	d.f.	Mean sum of squares					
		1st pick	2nd pick	3rd pick	4th pick	5th pick	Total
Replication	2	0.258	0.098	0.003	0.115	1.648	0.028
Establishment method(E)	2	0.774*	0.58*	0.047*	0.247	0.173	0.29*
Error	4	0.088	0.08	0.004	0.064	0.041	0.012
Nutrient management (N)	4	0.557*	1.284*	1.774*	3.201*	8.344*	2.466*
E×N	8	0.005	0.033	0.032	0.007	0.002	0.003
Error	24	0.179	0.092	0.003*	0.227	0.123	0.03
Total	44						

***Significant at 5% level of significance**

APPENDIX XVII

Analysis of variance for nitrogen content in baby corn at different harvesting stages

Source of variation	d.f.	Mean sum of squares					
		1st pick	2nd pick	3rd pick	4th pick	5th pick	Total
Replication	2						
Establishment method(E)	2	0.009*	0.014*	0.005*	0.005*	0.007*	0.008*
Error	4	0.0025	0.0025	0.0025	0.0025	0.0005	0
Nutrient management (N)	4	0.064*	0.131*	0.046*	0.04*	0.056*	0.064*
E×N	8	0.00012	0.00012	0.00037	0.00037	0.001	0.00012
Error	24	0.0025	0.00021	0.00025	0.00029	0.00037	0.00008
Total	44						

***Significant at 5% level of significance**

APPENDIX XVIII

Analysis of variance for protein content in baby corn at different harvesting stages

Source of variation	d.f.	Mean sum of squares					
		1st pick	2nd pick	3rd pick	4th pick	5th pick	Total
Replication	2	0.0065	0.001	0.006	0.001	0.002	0.002
Establishment method(E)	2	0.361*	0.554*	0.183*	0.199*	0.291*	0.305*
Error	4	0.002	0.004	0.009	0.003	0.017	0
Nutrient management (N)	4	2.484*	5.137*	1.788*	1.563*	2.193*	2.482*
E×N	8	0.003	0.003	0.017	0.013	0.019	0.006
Error	24	0.01	0.008	0.009	0.012	0.015	0.003
Total	44						

***Significant at 5% level of significance**

APPENDIX XIX

Analysis of variance for nutrient content in baby corn and green fodder

Source of variation	d.f.	Mean sum of squares					
		N content (%)		P content (%)		K content (%)	
		Corn	Green fodder	Corn	Green fodder	Corn	Green fodder
Replication	2		0.002	0.0005	0.0005		
Establishment method(E)	2	0.008*	0.014	0.009*	0.03*	0.001	0.001
Error	4	0	0.002	0.001	0.00025	0	0.001
Nutrient management (N)	4	0.064*	0.033*	0.067*	0.004*	0.015*	0.019*
E×N	8	0.00012	0.00025	0	0	0	0
Error	24	0.00008	0.001	0.000125	0.000125	0.001	0.001
Total	44						

***Significant at 5% level of significance**

APPENDIX XX

Analysis of variance for nutrient uptake by baby corn and green fodder

Source of variation	d.f.	Mean sum of squares								
		N uptake			P uptake			K uptake		
		Corn	Green fodder	Total	Corn	Green fodder	Total	Corn	Green fodder	Total
Replication	2	0.049	1.349	0.881	0.0005	0.169	0.1725	0.0005	0.789	0.762
Establishment method(E)	2	2.72*	59.39*	87.414*	0.426*	15.641*	21.121*	0.486*	122.988*	138.91*
Error	4	0.036	1.81	1.38	0.006	0.275	0.293	0.015	6.444	5.98
Nutrient management (N)	4	21.787*	452.58*	672.358*	2.929*	22.431*	41.527*	3.849*	1,244.79*	1,386.84*
E×N	8	0.04	0.59	0.812	0.008	0.218	0.291	0.007	1.283	1.389
Error	24	0.062	0.71	0.998	0.007	0.172	0.201	0.02	2.488	2.651
Total	44									

***Significant at 5% level of significance**

APPENDIX XXI

Analysis of variance for OC, N, P and K content of soil after harvesting of baby corn

Source of variation	d.f.	Mean sum of squares			
		OC	AN	AP	AK
Replication	2		7.769	0.491	142.220
Establishment method(E)	2	0.002	72.63*	13.853*	44.955*
Error	4	0.006	1.805	0.496	0.854
Nutrient management (N)	4	0.041*	766.012*	235.994*	1,817.09*
E×N	8	0.000	0.862	0.089	4.163
Error	24	0.006	9.733	3.084	11.062
Total	44				

***Significant at 5% level of significance**

APPENDIX XXII

Analysis of variance soil microbial population

Source of variation	d.f.	Mean sum of squares		
		Bacteria	Fungi	Actinomycets
Replication	2	1.689	3.097	0.0015
Establishment method(E)	2	4.022*	5.182*	0.292*
Error	4	0.356	1.010	0.018
Nutrient management (N)	4	38.744*	32.484*	4.245*
E×N	8	0.161	0.110	0.004
Error	24	1.439	0.609	0.007
Total	44			

***Significant at 5% level of significance**

APPENDIX XXIII

Analysis of variance for economics of baby corn

Source of variation	d.f.	Mean sum of squares			
		Gross return	Net return	B:C ratio	Net profit per day
Replication	2	86362279.8	86470936.5	0.113	24006.12
Establishment method(E)	2	1204393461.0*	1111959452.8*	0.840*	308869.47*
Error	4	2958398.2	2906632.4	0.005	811.296.00
Nutrient management (N)	4	11747870288.15*	12458786268.6*	20.044*	3460769.47*
E×N	8	13101853.2	12977717.5	0.048	3606.33
Error	24	40773809.0	40774196.9	0.028	112326.40
Total	44				

***Significant at 5% level of significance**

APPENDIX XXIV

Cost of cultivation of baby corn crop (per ha) during 2019-19

S.no.	particular	dose/ha	Rate @	Total	Remark
Land preparation					
	Ploughing	2	750	1500	
	Harrowing	2	750	1500	
	Planking	1	375	375	
			Total	3375	
Seed and sowing					
	Seed	30 kg	Rs 100 kg /ha	3000	
	Planting	8	235/labour	1880	Manually
	Bunding and furrow opening	8	235/labour	1880	Manually
			Total	6760	
Irrigation					
	Common irrigation	1	750/irrigation	750	
	Labour for application	4	235/labour	940	Manually
			Total	1690	
Weeding					
	Labour for spray	8	235/labour	1880	Manually
			Total	1880	
Herbicide					
	Labour for spray	2	235/labour	450+750= 1220	Manually
			Total	1220	
Insecticide					
	Labour for spray	2	235/labour	450+370= 840	Manually
			Total	840	
Harvesting					
	Labour for harvesting	15	235/labour	3525	Manually
			Total	3525	
Total cost				19290	
Variable cost					
Ridge preparation	1	500	500	700	
Nutrient cost	100% Vermicompost	10 t/ha	Rs 4/kg	50000	
	50% NPK {NPK (12:32:16) + Urea} + 50% vermicompost	94 kg+172 kg+5t	Rs 22/kg+Rs 6/kg	28100	
	75% NPK {NPK (12:32:16) + Urea} + 25 % vermicompost	140 kg+25 kg+2.5t	Rs 22/kg+Rs 6/kg	17134	
	100% NPK {NPK (12:32:16) + Urea}	188 kg+344 kg	Rs 22/kg+Rs 6/kg	6200	

VITA

The author, Abhishek Bahuguna was born on 21st January, 1994 at Belani, Rudraprayag, (Uttarakhand). He passed his High School and Intermediate examination from Sarasvati Vidhya Mandir, Rudraprayag and secured 18th position in high school state merit list. He has completed his B.Sc. (Ag.) degree from G.B.P.U.A & T, Pantnagar in 2017. He joined the same university for the degree of M.Sc. Agriculture with major in Agronomy in the year 2017. The author was also awarded with Dhanuka Agro Tech scholarship during his post-graduation.

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ABSTRACT

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Thesis title : **"EFFECT OF ESTABLISHMENT METHOD AND NUTRIENT MANAGEMENT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF BABY CORN (*Zea mays* L.)"**

Advisor : **Dr. Mahendra Singh Pal**

Field experiment was conducted during *Kharif* season-2018 at Instructional Dairy Farm (IDF), Nagla, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) to study the effect of establishment method and nutrient management on productivity, profitability and quality of baby corn (*Zea mays* L.). The soil of the experimental site was slightly silty clay loam in texture with neutral pH (7.16), rich in organic carbon (0.74%), medium in available nitrogen (282.51 kg/ha), medium in available phosphorus (28.16 kg/ha) and available potassium (235 kg/ha). The experiment consisted of 3 establishment methods i.e. flat, flat followed by earthing (flat + earthing) and ridge planting in main plot and 5 nutrient management options i.e. control (without fertilizer), 100% VC (N equivalent), 100% RDF (180: 60: 40 :: N: P_2O_5: K_2O kg/ha), 50% RDF (90: 30: 20 :: N: P_2O_5: K_2O kg/ha + 50% VC and 75% RDF (45: 15: 10 :: N: P_2O_5: K_2O kg/ha) + 25% VC in sub plot was laid out in Split Plot Design (SPD) with three replications. The baby corn var. "V.L. Baby corn-1" was sown on 7th June, 2018 and harvested on 8th August, 2018.

The growth attributes, baby corn, cob and green fodder yield, total soluble solids (TSS), protein content and N, P and K uptake were significantly influenced by establishment methods and nutrient management strategies. Among different establishment methods, ridge planting produced significantly higher baby corn yield with 7 and 14% higher than flat + earthing and flat planting, respectively. Ridge planted baby corn also recorded higher N, P and K content, TSS and protein content. Similarly, significantly highest gross return, net return, B:C ratio and net profit per day was recorded at ridge planting with 10 and 20% higher net return than flat + earthing and flat method, respectively. Among nutrient management options, 75% RDF + 25% VC gave significantly highest baby corn yield and it had 3, 13, 25 and 60% higher values than 100% RDF, 50% RDF + 50% VC, 100%VC and control, respectively. Similar trend was also observed in baby cob and green fodder yield. The quality parameters i.e. TSS and protein content were also recorded significantly higher under 75% RDF + 25% VC that was statically at par with 100% RDF. However, application of 100% VC recorded significantly highest available nitrogen, phosphorus and potassium content and microbial count i.e. bacteria, fungi and actinomycets in soil after crop harvest. The gross return was also found highest under 75% RDF + 25% VC but non-significant with 100% RDF, however, net return and B:C ratio were significantly highest under 100% RDF.

The experimental results indicated that the higher productivity, profitability and quality of baby corn as well as sustainability of the production system may be achieved by planting baby corn on ridges with application of 75% RDF + 25% VC in Indo-Gangetic plains of India and saves 25% NPK compared to 100% RDF. However, it requires more field experimentation for conformity of the results.

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प्रमुख विषय	:	सस्य विज्ञान	विभाग	:	सस्य विज्ञान
शोध शीर्षक	:	''बेबी कॉर्न (*जिया मेज* एल.) की उत्पादकता, लाभप्रदता एवं गुणवत्ता पर स्थापना विधि एवं पोषण प्रबन्धन का प्रभाव''			
परामर्शदाता	:	डॉ० महेन्द्र सिंह पाल			

सारांश

प्रस्तुत शोध ''बेबी कॉर्न (*जिया मेज* एल.) की उत्पादकता, लाभप्रदता एवं गुणवत्ता पर स्थापना विधि एवं पोषण प्रबन्धन का प्रभाव'' विषय पर अध्ययन हेतु प्रक्षेत्रीय प्रयोग वर्ष 2018 के खरीफ मौसम के दौरान निर्देशात्मक डेयरी फॉर्म (आईडीएफ), नगला, गोविन्द बल्लभ पंत कृषि एवं प्रौद्योगिकी विश्वविद्यालय, पन्तनगर (उत्तराखण्ड) में सम्पादित किया गया । परीक्षण प्रक्षेत्र की मृदा हल्की सिल्ट क्ले दोमट जिसमे जैविक कार्बन (0.74%) तथा नत्रजन (282.5 किग्रा०/हे०), फॉस्फोरस, (28.16 किग्रा०/हे०) एवं पोटेशियम (235 किग्रा०/हे०) की उपलब्धता मध्यम थी। भूमि का पी.एच. मान सामान्य (7.16) था। परीक्षण में 3 स्थापना विधियों जैसे – समतल, समतल + भूयोजन एवं मेढ़ रोपण की विधि को मुख्य प्लॉट में एवं 5 पोषण प्रबंधन विकल्प जैसे – नियंत्रण (उर्वरक रहित), 100% वर्मीकम्पोस्ट (नत्रजन समकक्ष), 100% आर०डी०एफ० (180 : 60 : 40 :: $N : P_2O_5 : K_2O$ किग्रा/हे०), 50% आर०डी०एफ० (90 : 30 : 20 :: $N : P_2O_5 : K_2O$ किग्रा/हे०) + 50% वर्मीकम्पोस्ट और 75% आर०डी०एफ० (45 : 15: 10 :: $N : P_2O_5 : K_2O$ किग्रा/हे०) + 25% वर्मीकम्पोस्ट को उपप्लॉट में तीन अनुकरण के साथ विखण्डन प्लॉट डिजाइन (SPD) में आयोजित किया गया। बेबी कॉर्न की किस्म ''वी०एल० बेबी कॉर्न–1'' को 7 जून, 2018 में बोया एवं 8 अगस्त, 2018 को काटा गया था।

विकास विशेषताएँ, बेबी कॉर्न उपज, कुल घुलनशील पदार्थ (TSS), प्रोटीन मात्रा एवं N, P एवं K उद्ग्रहण विभिन्न स्थापना विधियों एवं पोषण प्रबंधन की युक्तियों से सांख्यिकीय रूप से प्रभावित पाये गये। विभिन्न स्थापना पद्धतियों के तुलनात्मक अध्ययन में मेढ़ रोपण पद्धति ने सांख्यिकीय रूप से समतल + भूयोजन एवं समतल बोने की पद्धति से क्रमशः 7 एवं 14 प्रतिशत अधिक बेबी कॉर्न उपज दर्ज की। N, P ,K मात्रा ,कुल घुलनशील पदार्थ (TSS), प्रोटीन मात्रा, सकल आय, शुद्ध आय, B:C अनुपात एवं शुद्ध आय प्रतिदिन मेढ़ रोपण विधि में सर्वाधिक दर्ज की गयी एवं मेढ़ रोपण ने समतल + भूयोजन एवं समतल विधि के मुकाबले क्रमशः 10 एवं 20 प्रतिशत अधिक शुद्ध आय दर्ज की। विभिन्न पोषण प्रबन्ध विकल्पों में सांख्यिकीय रूप से अधिकतम बेबी कॉर्न उपज 75% आर०डी०एफ० + 25% वर्मीकम्पोस्ट के उपयोग करने पर प्राप्त हुई जोकि 100% आर०डी०एफ०, 50% आरडीएफ + 50% वर्मीकम्पोस्ट ,100% वर्मीकम्पोस्ट एवं नियंत्रण की तुलना में क्रमशः 3, 13, 25 एवं 60 प्रतिशत अधिक थी। बेबी कॉब एवं हरे चारे की उपज में भी इसी प्रकार का प्रचलन देखा गया। गुणवत्ता मापदंड जैसे – TSS एवं प्रोटीन मात्रा भी सांख्यिकीय रूप से 75% आर०डी०एफ० + 25% वर्मीकम्पोस्ट के प्रयोग में अधिक पायी गयी जोकि 100% आर०डी०एफ० के साथ सांख्यिकीय रूप से बराबर थी। फसल कटाई के उपरांत मृदा में उपलब्ध नत्रजन, फॉस्फोरस, पोटेशियम एवं सूक्ष्म जीव संख्या(जैसे–बैक्टीरिया, कवक एवं एक्टीनोमाइसिटस), 100% वर्मीकम्पोस्ट के प्रयोग के साथ सांख्यिकीय रूप से अधिक दर्ज की गयी। 75% आर०डी०एफ० + 25% वर्मीकम्पोस्ट के प्रयोग से सर्वाधिक सकल लाभ मिला जोकि सांख्यिकीय रूप से 100% आर०डी०एफ० के बराबर था। जबकि शुद्ध आय एवं B:C अनुपात सांख्यिकीय रूप से 100% आर०डी०एफ० में अधिक दर्ज किया गया।

परीक्षण के परिणाम बताते है कि बेबी कॉर्न की उच्च उत्पादकता, लाभप्रदत्ता एवं गुणवत्ता के साथ–साथ मृदा तंत्र की संवहनीयता प्राप्त करने के लिए इसे मेढ़ रोपण में 75% आर०डी०एफ० + 25% वर्मीकम्पोस्ट का प्रयोग करके भारत के गंगा के मैदानी इलाकों में सफलतापूर्वक उगाया जा सकता हैं और 100% आर०डी०एफ० की तुलना में 25% नत्रजन की बचत भी की जा सकती हैं। उपरोक्त परिणामों के सत्यापन हेतु और अधिक प्रक्षेत्र परीक्षण करने की आवश्यकता है।

(महेन्द्र सिंह पाल)	(अभिषेक बहुगुणा)
सलाहकार	लेखक