Yield and quality of sweet corn (*Zea mays var. saccharata*) under different fertility levels and time of harvest

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By

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Date: 17th August 2020

CERTIFICATE-I

This is to certify that the thesis entitled "**Yield and quality of sweet corn *(Zea mays var. saccharata*) under different fertility levels and time of harvest**" submitted in partial fulfilment of the requirements for the award of degree of **MASTER OF SCIENCE IN AGRICULTURE (AGRONOMY)** to the Odisha University of Agriculture and Technology is a faithful record of *bona fide* and original research work carried out by **Mr Nityashree Pradhan** under my guidance and supervision. No part of this thesis has been submitted for the award of any other degree or diploma.

It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

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CERTIFICATE-II

This is to certify that the thesis entitled "**Yield and quality of sweet corn *(Zea mays var. saccharata*) under different fertility levels and time of harvest**" submitted by **Mr Nityashree Pradhan** to the Odisha University of Agriculture and Technology, Bhubaneswar in the partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE (AGRONOMY)** has been approved/disapproved by the student's advisory committee and the external examiner.

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ABSTRACT

A field experiment was conducted at Agronomy Main Research Farm, Department of Agronomy, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar under the East and South Eastern Coastal Plain Zone of Odisha during rabi season of 2019-20 under irrigated situation to study the effect of fertility level and time of harvest on yield and quality of sweet corn *(Zea mays* var. *saccharata*). The soil of the experimental field was well drained, sandy loam in texture having pH 5.72. The available nutrient status of the soil was medium in nitrogen, phosphorus and potassium. The experiment was laid out in a split-plot design with three levels of fertility (120:60:60 kg, 80:40:40 kg and 40:20:20 kg N, P_2O_5 and K_2O ha^{-1}) in the main plot and five dates of harvest (16, 20, 24, 28, and 32 days after silking) in the sub-plot with three replications. The seed of sweet corn hybrid Sugar 75 was sown on 23rd November 2019 with a spacing of 60 cm X 25 cm. The crop growth rate was hastened with increase in fertility level, which was evidenced from the minimum days required for 50 % tasseling (50.7) and 50 % silking (54.1) with application of 120:60:60 kg N, P_2O_5 and K_2O ha^{-1}. Application of 120:60:60 kg N, P_2O_5 and K_2O ha^{-1} produced maximum yield of green cob (15.63 t ha^{-1}), fresh kernel (7.86 t ha^{-1}) and green fodder (36.42 t ha^{-1}). Application of 120:60:60 kg N:P_2O_5:K_2O ha^{-1} yielded 23.5 per cent more green cob, 28.9 per cent more fodder and 14.9 per cent more kernel as compared with fertility level of 40:20:20 kg N:P_2O_5:K_2O ha^{-1}. There was significant increase in green cob yield (15.22 t ha^{-1}) up to 24 days after silking after which yield enhancement was not significant. Total soluble sugar content of the kernel increased with advancement in date of harvest and attained its maximum (12.9%) at 24 days after silking and declined then after. The protein content in the grain was the maximum (7.47%) with application of 120:60:60 kg N, P_2O_5 and K_2O ha^{-1}. Harvesting the crop at 32 days after silking resulted in maximum protein content (7.35%) in kernel. Application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare recorded the maximum uptake of nitrogen (93.6 kg ha^{-1}), phosphorus (35.9 kg ha^{-1}) and potassium (147.5 kg ha^{-1}). Harvesting the crop at 32 days after silking recorded the maximum uptake of 91.0 kg nitrogen, 36.0 kg phosphorus and 144.2 kg potassium per hectare. The highest net profit of Rs 108732 ha^{-1} and benefit: cost ratio of 3.03 were obtained with application of 120:60:60 kg N:P_2O_5:K_2O ha^{-1}. Optimum net profit of Rs 107075 per hectare was received with harvesting the crop at 24 day after silking.

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INTRODUCTION

Maize (*Zea mays* L) is an important cereal crop grown for preparation of various diversified products such as human food, animal feed, fish feed, industrial products and many more. Maize is a wonder crop having excellent production potential and considered as important after wheat and rice (Nagaraju *et al*., 2019). In our country, this crop is cultivated in most of the states with varied management practices and assorted objectives. This crop is widely cultivated in an area of nearly 9.18 million hectare with the grain yield of 2965 kg per hectare and production of 27.23 million tonnes during 2018-19 in India (DES, 2020). In recent time, sweet corn has emerged as an alternative food source for the diverse section of people starting from rural areas to metro cities. Sweet corn is gaining importance throughout the globe including India.

Sweet corn occupies an important place among various types of speciality corns due to its consumption pattern in roasted, boiled and other forms. According to Abhishek and Basavanneppa (2020), sweet corn is usually eaten at green cob stage in boiled, steamed or roasted form and consumed with wide variety of other products. The demand for sweet corn is expanding in domestic and international markets due to its pleasant taste. In recent time, consumers of different areas prefer sweet corn due to high sugar content (Game *et al*., 2017). This crop has the potentiality to be grown as a remunerative crop and provide ample of employment opportunity in the rural areas.

Sweet corn is unique among other types of corn due to higher sugar and low starch content in the kernel. Sweet corn is a mutant type accommodating one or more recessive alleles in homozygous condition, which enables the endosperm to accumulate higher sugar content as compared with normal maize. The kernels of sweet corn are having a sweetish translucent starch, which has horny appearance at immature stage and gives wrinkled appearance after drying. Normal maize cultivated for grain purpose is harvested when kernels are mature and dry. But in case of sweet corn, the green cobs are harvested at immature stage when the kernels are soft and dough. Besides production of green cob, sweet corn produces adequate quantities of green fodder, utilized as animal feeding.

Sweet corn is believed to be grown by American Indians, but subsequently was gathered by European persons during 1770s. Venkatesh *et al*. (2003) reported that sweet corn was developed from the mutation of single gene (*su*) in Peruvian race 'Chullpi'. Most of the commercial sweet corn genotypes are having one or more simple recessive alleles such as *shrunken2 (sh2), sugary1 (su1)* and *sugary enhancer1 (se1)*, which convert carbohydrates of the endosperm and enhance sweetness (Boyers and Shannon, 1984).

It is imperative to develop suitable production technology for obtaining higher yield and more profit from sweet corn. Sweet corn production technology may be refined based on local agro-ecological situations to obtain sustainable yield over years. Among various crop management practices, fertilizer management has an important role in deciding the quantum of good quality sweet corn production. Sweet corn is a heavy feeder crop that needs considerable quantity of major plant nutrients viz. nitrogen, phosphorus and potassium (Ortas and Sari, 2003). As an exhaustive crop, sweet corn needs more quantity of plant nutrients for optimum growth and higher production. The effect of plant nutrients on sweet corn production varies depending on cultivar used, growing condition and management options. Higher rate of fertilizer application stimulates absorption of plant nutrients thereby accelerating plant growth. Besides, nutrients help in efficient utilization of solar radiation for production of more photosynthates by the plant. Variation in fertilizer application noticeably affects various yield attributing factors such as ears per plant, kernels per cob and kernel weight; which ultimately influences the yield. The quality of sweet corn is also substantially affected by fertilizer application. Capon *et al*. (2017) reported that presence of protein, sugar and starch in sweet corn is influenced by variation in fertilizer management.

Date of harvest plays a vital role in obtaining expected yield of sweet corn. Sometimes, farmers prefer to harvest the crop earlier to avail the benefit of higher market price. Similarly, many farmers opt for delayed harvest in order to enhance the quantity of sweet corn production. But, premature harvest of cobs at an early date reduces the quantity and quality of production, whereas delayed harvest produces poor quality sweet corn due to less sugar content in the kernel. Precision in deciding the date of harvesting determines the quality of sweet corn, which ultimately influences the market demand. There is paucity of scientific literature regarding the effect of date of harvesting on yield and quality of sweet corn. As per Mehta *et al*. (2017), nearly 64 per cent of the genotypes of super sweet corn attained the highest brix percentage at 24 days after pollination. Other researchers have reported different dates of harvest to obtain maximum sugar content of sweet corn. Studying on several genotypes, Khanduri *et al*. (2011) recorded maximum value of kernel sugar concentration at 20 days after pollination, which reduced gradually from 20 till 28 days after pollination. Similarly, Szymanek (2009) reported that delay in harvesting of corn cobs reduced the levels of sugar in the kernel.

With this backdrop, it was required to find out suitable fertility level and appropriate harvesting date to maximize production of good quality sweet corn. With this background, an experiment was carried out in Main Research Farm, Department of Agronomy, College of Agriculture, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar under East and South Eastern Plain Agro-climatic Zone of Odisha during rabi season of 2019-20. The broad objectives of the experimentation are given hereunder:

- To determine the effect of fertility level on the growth and yield of sweet corn
- To determine the effect of time of harvest on the yield and quality of sweet corn
- To determine the economics of sweet corn cultivation

REVIEW OF LITERATURE

Sweet corn is one of the potential crop, which can provide income and employment for the rural farmers. As compared to grain crop of maize, the net income from sweet corn is reasonably higher (Khadtare *et al*., 2006). Like other crops, sweet corn is largely influenced by environmental factors and management practices. The crop can survive even at temperature as low as 0 ^{0}C and as high as 44 ^{0}C, but the growth process retards at temperature below 4.9 ^{0}C (Dass *et al*., 2005). Variation in local weather parameters directly affects the plant growth parameters of sweet corn crop. The growth process of maize is adversely influenced by extreme temperature events for a prolonged period. Exposure to temperature below 10 ^{0}C for a long time decreases leaf expansion (Miedema, 1982). Optimum temperature range between 30-35^{0}C is suitable for shoot, root and leaf development of maize (Zaidi and Singh, 2005).

Now-a-days, the farmers prefer to go for sweet corn cultivation because of sweet taste and tenderness of green cobs (Dhaka *et al*., 2014). Therefore, adequate efforts are required for generation of location specific technology for this crop. Among various agronomic practices, fertilizer application has an important role for obtaining more productivity and good quality of sweet corn. The major plant nutrients such as nitrogen, phosphorus and potassium have considerable effect on crop growth and production of good quality sweet corn. Similarly, date of harvest decides the quality of sweet corn to fetch good price in the market. In the subsequent pages, efforts have been made to gather the appropriate research literature on these aspects.

2.1 Effect of fertility level

Sweet corn is a heavy feeder, which requires higher quantity of major nutrients such as nitrogen, phosphorus and potassium for growth and production. (Ortas and Sari 2003). This crop has more potentiality for nutrient consumption as compared with other crops. Several authors (Jaliya *et al*., 2008; Asghar *et al*., 2010 and Uwah *et al*., 2011) have opined that enhancement in application of plant nutrient stimulates their absorption, enhances the translocation, improves utilization of incident solar radiation and promotes photosynthetic activities. Based on growing condition and crop management practices, the effect of fertilizer application differs from place to place. There is variation in nutrient requirement of sweet corn depending on inherent fertility status of soil, cropping season and variety used.

2.1.1 Plant growth

The development of the plant is assessed from the progressive development of stem, leaf and root; which are expressed in the form of plant height, stem girth, leaf number & leaf area and root length & root biomass production. Various authors have recorded the effect of plant nutrients on such growth parameters. As per Zende (2006), enhancement in quantity of applied nutrients accelerates the plant growth and production of dry matter.

Nitrogen contributes immensely for growth and productivity of sweet corn crop. As per Sahoo and Mohanty (2020) precise management of nitrogen is necessary to realize higher yield though maintaining soil health. According to Sonbai *et al*. (2013), increase in absorption of inorganic nitrogen fertilizer increases chlorophyll production in plant, which ultimately enhances carbohydrate production. As per Bavec *et al*. (2015), there is development of deeper root system in sweet corn due to low level of nitrogen availability in the soil. Under Almora situation, Pandey *et al*. (2002) observed that per hectare nitrogen application to the tune of 120 kg enhanced plant height considerably. Increased application of N to the level of 180 kg per hectare remarkably augmented green leaf number (Singh *et al*., 2003). Enhancement in number of green leaves was ultimately responsible for enhanced dry matter production of the plant.

The role of phosphorus and potassium is important in deciding the rate of growth of root and above ground plant parts. Massey and Gaur (2006) recorded taller plants, more no. of leaves per plant and higher leaf area by providing 90 kg N and 45 kg P_2O_5 per hectare. Dangariya *et al.* (2017) from Gujrat reported that application of 150 kg nitrogen and 75 kg phosphorus per hectare recorded tallest plants with thickest stem and maximum leaf number per plant. Absent of plant nutrients in the soil influences root development to a significant level. Rao *et al*. (2020) from Odisha recorded tallest plants (216.3cm) with application of $N:P_2O_5:K_2O$ @ 120:60:60 kg ha^{-1} in combination with bio-fertilizer consortia. Under Pantnagar situation, Singh *et al*. (2019) observed that fertility level of 120, 60 and 40 kg N, P_2O_5 and 40 K_2O per hectare respectively produced the tallest plants (134.5 cm) in sweet corn. Application of 150:60:50 kg $N:P_2O_5:K_2O$ ha^{-1} recorded The tallest plants of 160 cm at tasseling and 171 cm at harvest was resulted due to proper utilization of available nutrients from inorganic sources which has intensive effect on plant growth (Nagaraju *et al*., 2019). As per Jat *et al*. (2009), providing major nutrients @ 120:60:60 kg $N:P_2O_5: K_2O$ ha^{-1} produced the tallest plants.

2.1.2 Leaf area index

Fertilizer application has direct effect on no. of leaves and leaf area, which determines the leaf area index of sweet corn. The leaf expansion in maize plant is considerably affected by nitrogen fertilization. Soil application of as high as 180 kg nitrogen per hectare resulted in higher number of leaf count (Singh *et al.,* 2003). Under Pantnagar situation, Shivay and Singh (2000) recorded enhanced size of leaf with enhancement in nitrogen application to a level of 120 kg per hectare. Kumar *et al*. (2007) realized higher leaf size by increasing the rate of NPK application. Rao *et al*. (2020) from Odisha realized better crop growth and leaf aspects with increased application of major nutrients.

2.1.3 Accumulation of dry matter

Supply of plant nutrients in the soil has direct bearing on accumulation of dry matter. Among nutrients nitrogen has a significant role in dry matter production of sweet corn. In maize crop, enhancement in nitrogen application up to 120 kg per hectare increased the addition of dry matter in the plant (Singh *et al.,* 1993). As per Kumar *et al*. (2007), dry matter production was increased in sweet corn with increase in NPK application. Singh *et al*. (2019) observed that provision of 120:60:40 kg $N:P_2O_5:K_2O$ ha^{-1} resulted in the highest production of dry matter (82.1 g $plant^{-1}$) in sweet corn. Under Junagarh situation, Mathukia *et al*. (2014) realized tallest plants (178 cm), maximum number of leaves (14.7) per plant and maximum accumulation of dry matter (144 g $plant^{-1}$) with provision of 150 kg nitrogen and 75 kg phosphorus per hectare. It was at par with application of 120 kg N and 60 kg P_2O_5 per hectare. This may be attributed to synthesis of higher amount of amino acids and other growth promoting substances because of enhanced supply of nitrogen and phosphorus.

2.1.4 Crop growth rate

Adequate availability of plant nutrients accelerates cell division thereby enhancing rate of morphological development, which increases growth rate of crop and the relative crop growth rate. Akpan and Udoh (2017) reported that fertilizer application in enhanced quantity resulted in better growth in various sweet corn varieties. Okeleye and Oyekanmi (2003) opined that there is linear increase in crop growth rate with increase in N level. Combination of phosphorus and potassium with nitrogen enhances the rate of crop growth rate in sweet corn. Suthar *et al.* (2012) recorded tallest plants, maximum accumulation of dry matter with enlarged leaf area when the crop was provided with 90 kg nitrogen and 40 kg phosphorus per hectare.

2.1.5 Tasseling and silking

Duration of a crop plays an important role for efficient utilization of land by accommodating succeeding crop in time. Application of major plant nutrients accelerates the process of plant growth and hence induces early flowering in maize. Sahoo and Panda (1997) observed that the plant growth period of baby corn is minimized with higher level of fertilizer application. They reported delay in emergence of tassel and silk in absence of fertilizer application.

2.1.6 Yield attributing characters

Increase in application of fertilizer considerably improves various yield attributing characters of sweet corn such as cobs per plant and number & weight of kernel because of accelerated physiological activities of the plant (Sahoo and Mohanty, 2020). More grains per cob and higher grain weight were reported by Jaliya *et al*. (2008) with application of 150:26:50 kg $N:P_2O_5:K_2O$ ha^{-1}. Shanti *et al.* (2012) from Hyderabad obtained thickest (12.43 cm) and longest (15.83 cm) cobs when the crop was provided with N, P_2O_5 and K_2O @ 150, 75 and 45 kg ha^{-1}, respectively. Under Tirupati situation, Sunitha and Reddy (2012) realized heaviest green cobs along with maximum kernels cob^{-1} by fertilizing the crop with 150:70:50 kg $N:P_2O_5:K_2O$ ha^{-1}. Inadequate availability of plant nutrients adversely affects the yield attributing characters of the plant. Nagraju *et al.* (2019) from Bapatla applied 150 kg N, 60 kg P_2O_5 and 50 kg K_2O per hectare to record maximum kernel count (308) per cob. Under Odisha situation, Sahoo and Mahapatra (2007) realized more barren plants (28.2%), lighter cobs (84 g) with less number of kernels (144 cob^{-1}) in absence of fertilizer application in sweet corn.

Several authors have reported that nitrogen application influenced various yield deciding parameters of sweet corn. Mahmood *et al.* (2001) opined that nitrogen had a significant effect on number of grains per cob, grain weight and harvest index. Increase in nitrogen levels increased the cob length (Gokmen *et al*., 2000) and ear diameter (Grazia *et al*., 2003). Jat and Balyan (2004) observed that enhancement of nitrogen level up to 150 kg per hectare produced longest green cob and the maximum number of grains per cob. More number of cobs with production of longest and thickest cobs was attained by per hectare application of 60 kg potash (Singh *et al.*, 2003). Longer, thicker and heavier cobs were also realized by Dangariya *et al*. (2017) when provided with 150 kg nitrogen and 75 kg phosphorus per hectare.

2.1.7 Yield of green cob and kernel

Various workers go evidence regarding noteworthy contribution of major plant nutrients on yield of sweet corn. Under Ludhiana situation, Kumar and Chawla (2018) recorded maximum green cob yield (11.41 t ha^{-1}) with nutrient level of 150:50:60 kg $N:P_2O_5:K_2O$ ha^{-1}. But, Thorat *et al*. (2016) recommended provision of 150:75:50 kg $N:P_2O_5:K_2O$ ha^{-1} for obtaining highest yield of green cob. Under Tirupati situation, Sunitha and Reddy (2012) also recommended provision of 150:70:50 kg $N:P_2O_5:K_2O$ ha^{-1} to harvest maximum green cob. Sahoo and Mahapatra (2008) recorded maximum per hectare green cob yield of 12.04 tonne by applying the nutrients @ 80:40:40 kg $N:P_2O_5:K_2O$ ha^{-1} under rainfed situation during kharif season. Singh *et al*. (2012) realized maximum sweet corn yield by applying 120 kg nitrogen per hectare. During winter season, provision of 120 kg nitrogen per hectare resulted in the maximum sweet corn yield (Sahoo and Mahapatra, 2004). Abhishek and Basavannepp (2020) from Siruguppa, Karnataka obtained maximum fresh cob yield of 13.86 t ha^{-1} by applying as high as 262.5 kg nitrogen per hectare.

Massey and Gaur (2013) reported that fertilizer rate of 90 kg nitrogen and 45 kg phosphorus per hectare significantly increased the green cob yield. In clay loamy soils of Udaipur, Priyanka *et al*. (2014) also obtained the highest yield of green cob by providing 90 kg nitrogen and 40 kg phosphorus per hectare. Dangariya *et al*. (2017) obtained maximum green cob yield of 8.10 t ha^{-1} by providing 120 kg N and 60 kg P_2O_5 ha^{-1}. But under high soil P status, application of phosphorus had no effect on sweet corn yield (Geleta *et al*., 2004). Similarly, Mathukia *et al*. (2014) from Junagarh reported that fertility level of 120 kg nitrogen and 60 kg phosphorus per hectare resulted in the maximum yield of green cob (8.0 t ha^{-1}).

The yield of kernel, the real consumption part of the sweet corn is also remarkably affected by various levels of fertility. Roongtanakiat *et al*. (2000) realized the highest yield of grain from super sweet corn hybrid with by applying 75 kg each of nitrogen, phosphorus and potash per hectare.

2.1.8 Yield of green fodder

Fertilizer application in sweet corn has a deciding role in the production of green fodder after harvest of green cob. Under Bengaluru situation, Ramachandrappa *et al.* (2004) obtained the highest green fodder yield with fertilizer dose of 150:75:40 kg $N:P_2O_5:K_2O$ ha^{-1}. Shetye *et al*. (2019) realized the maximum yield (26.19 t ha^{-1}) of green fodder with fertilizer schedule of 75% RDN through chemical fertilizer and 25% RDN through vermi-compost. Nagaraju *et al*. (2019) obtained maximum stover yield with nutrient level of 150:60:50 kg $N:P_2O_5:K_2O$ ha^{-1}. In a clayey soil of Junagadh, Mathukia *et al*. (2014) obtained the highest yield (36.66 t ha^{-1}) of green fodder by providing 120 kg N and 60 kg P_2O_5 ha^{-1}.

Dangariya *et al*. (2017) recorded significant increase in green fodder yield of 34.33 tonne per hectare with application of 150 kg N and 75 kg P_2O_5 ha^{-1}. This is due to the influence of plant nutrients on plant height, functional leaves, number of leaf and stem diameter. Rathod *et al.* (2018) from Gujrat harvested maximum quantity of fodder (31.17 t ha^{-1}) by applying 120 kg nitrogen and 60 kg phosphorus per hectare.

2.1.9 Quality of sweet corn

Market demand is mostly influenced by the sweet corn quality, which decides the ultimate profitability of cultivation. Presence of soluble sugar and protein in the kernel is remarkably affected by availability of plant nutrients in the soil. Protein, sugar and starch content in sweet corn are influenced by fertilizer management (Capon *et al.*, 2017). The maximum protein content in grain (14.85%) was recorded by Kaur *et al* (2019) with fertilizer scheduling of 75% of RDF combined with organic source of nutrients. Oktem *et al.* (2010) obtained more protein in kernels by application of enhanced quantity of nitrogen to the crop. Pangaribuan *et al*. (2017) supplied 150 kg N per hectare to obtain better quality of sweet corn with higher sucrose content. Abhishek and Basavanneppa (2020) recorded higher protein (10.39%) and starch content (47.97%) in sweet corn by applying nitrogen @ 262.5 kg ha^{-1} primarily because of availability of more nitrogen to sweet corn crop.

Under Amberpet (Hyderabad) situation, Raja (2001) recorded enhanced values of sugar and protein content when nitrogen level increased from 0 to 120 kg per hectare. Chen *et al*. (1993) reported enhancement in water-soluble sugar content of fresh grain with increase in K application.

2.1.10 Nutrient uptake

Akpan and Udoh (2017) reported that higher rate of fertilizer application accelerated plant growth and ultimately the reflected in enhanced removal of various plant nutrients. Higher rate of nutrient uptake is a boon for sweet corn crop as it helps in enhanced plant growth, production of dry matter and green cob yield (Saeed *et al*., 2016). Higher uptake of NPK in maize was also realized by Meena *et al.* (2007) by applying nitrogen dose of 120 kg ha^{-1} under Gujarat situation in the *rabi* season. Under Ranchi situation in Jharkhand, Singh and Sarkar (2001) observed that enhancing nitrogen application from 180 to 240 kg ha^{-1} enhanced removal of the nutrient from soil. Under Coimbatore situation, Ananthi *et al*. (2010) experienced enhanced uptake of nitrogen by increasing application of the nutrient during the wet season. Conducting experiment at Tirupati, Sunitha and Reddy (2012) reported that nitrogen, phosphorus and potassium uptake of sweet corn augmented significantly with each successive enhancement in nutrient application to the tune of 150:70:50 kg $N:P_2O_5:K_2O$ ha^{-1}.

2.1.11 Economics of cultivation

It is very much required for managing the economics of cultivation of a crop for sustainable production in the farmers' field. Sweet corn, being no exception, needs appropriate strategy to minimize the cost of production and maximize net profit. Several researchers have attempted to determine the profitable modalities of growing this crop under different growing environment. Kumar and Chawla (2018) from Ludhiana in Punjab attempted to obtain the maximum net return of Rs 31073 per hectare and benefit-cost ratio of 1.69 through addition of 150 kg N, 50 kg P_2O_5 and 60 kg K_2O ha^{-1}. Compared with the recommended fertilizer dose, twenty five per cent of additional supply of NPK to the crop resulted in net profit of Rs 1,33,858 per hectare as recorded by Singh e*t al*. (2019). Under Jashipur situation in Odisha, Sahoo and Mahapatra (2007) realized the per hectare net profit of Rs 45084 with application of 120:60:60 kg N: P_2O_5: K_2O. The record value of benefit cost ratio (3.43) was recorded by Sunitha and Reddy (2012) by providing nitrogen, phosphorus and potash @ 150, 70 and 50 kg per hectare, respectively. The encouraging profit of Rs 76869 per hectare was reported from Junagarh in Gujrat by Mathukia et al. (2014) when the sweet corn crop was provided with 150 kg N and 75 kg P_2O_5. The rainfed situation for growing sweet corn did not lag behind with respect to higher monetary return. Prasanna *et al.* (2007) obtained maximum net profit of Rs 20898 per hectare by applying hundred per cent recommended dose of fertilizer. The positive effect of nitrogen on economics of cultivation was depicted by Chauhan (2010) under Anand situation in Gujrat. He realized per hectare net profit of Rs 38202 by applying 120 kg nitrogen to the crop. Rao *et al.* (2020) from Parlakhemundi in Odisha obtained the maximum net profit by applying chemical fertilizer along with bio-fertilizer consortium.

2.2 Effect of date of harvest

Sweet corn with a high sugar concentration in the endosperm fetches good price in the marketing, which ensures higher profit from the crop. Sweetness is decided by the genetic make-up of the variety as well as management practices, especially time of harvest. As per Ruan *et al.* (1999), precision in deciding time of harvest is very much required to ensure higher quantity and good quality of sweet corn yield. However, there is paucity of adequate research information on the influence of harvesting time on the quality and productivity of sweet corn.

2.2.1 Cob Yield

Green cob yield of sweet corn is very much influenced by the suitable time of harvest. Delay in harvest may cause loss of quality but early harvest may result in poor yield of low quality sweet corn. There is direct effect of length of grain filling on the quantity of grain yield. Hence, extension of grain filling period with delay in harvest can enhance sweet corn production. Under the Philippines situation, Ducanes (1984) observed that 28 to 32 days after silking is the optimum time of harvest of sweet corn. But under Yugoslavia situation, Bebic and Radosavljevic (1985) recommended harvesting of green cobs at 30 days after fertilization. On the contrary, Sumitra *et al.* (1992) from Thailand reported that 16-22 days after 50 % silking stage is the appropriate time for harvest to obtain good quality sweet corn.

2.2.2 Quality of sweet corn

Sweetness of green cob is the most important deciding factor for determining the market price of sweet corn. Further, harvesting date has direct effect on the sugar content of sweet corn. Hence, to obtain good quality sweet corn with high sugar content, decision may be taken precisely on date of harvest. Szymanek (2009) opined that the sweetness of the green cob changes rapidly during the maturity period of the crop. As the crop approaches maturity, the sugar present in the kernel changes to starch thereby influences the green cob quality adversely (Venkatesh *et al*., 2003). Kulvadee *et al*. (1996) also observed that delay in harvesting increased the protein and fat content of the grain and hardening its texture. Khanduri *et al*. (2011) reported that sugar concentration of kernel has attained its peak at 20 days after pollination and gradually depleted at 24 and 28 days after pollination under controlled pollination. Similar findings were reported by Supapun and Pornpun (1985) under Thailand situation, who recorded maximum sucrose content of sweet corn seeds with harvest at 20 days after silking.

MATERIALS AND METHODS

3.1 Experimental site

The field experimentation was taken up at the Main Research Farm, Department of Agronomy, College of Agriculture, (OUAT), Bhubaneswar in the *rabi* season of 2019-20 to study the influence of fertility level and time of harvest on quality and productivity of sweet corn *(Zea mays* var. *saccharata*).

3.2 Location

The geographical location of Agronomy Main Research Farm, Department of Agronomy, OUAT, Bhubaneswar is of 20^0 15’N latitude and 85^0 52’E longitude with the altitude of 25.9 meter above mean sea level, which comes under the East and South Eastern Coastal Plain Zone of Odisha.

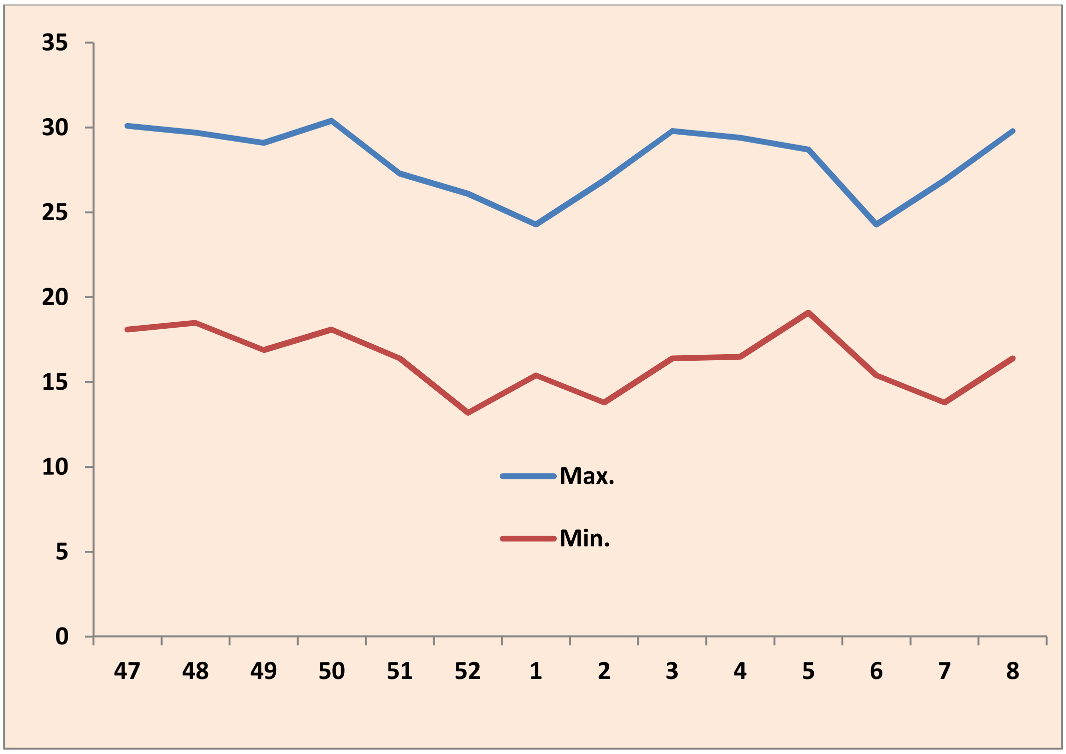
3.3 Climate and weather condition

Climatic condition of the experimental site is hot, moist and sub-humid with hot and humid summer and mild winter. The place is about 65 km away from Bay of Bengal. Weekly average meteorological data such as rainfall, maximum and minimum temperature, relative humidity, pan evaporation and bright sunshine hours during the period of study were obtained from the Central Research Station (OUAT), Bhubaneswar. In Odisha, South-west monsoon sets on 10^{th} June and recedes by mid of the month October. D_1E_3 ($B_1A_2B_1$) $C_1D_1E_2$ is the average rainfall code of Bhubaneswar (Lenka, 1976).

During the cropping season, mean maximum weekly temperature of 30.4 ^{0}C was recorded during 50^{th} Meteorological week. Similarly, the mean minimum weekly temperature of 13.2 ^{0}C was recorded during last meteorological week (24-31 December) of the year 2019 (Table 3.1, Fig. 3.1). Average weekly relative humidity in the forenoon was recorded the maximum (97 %) during 3^{rd} & 8^{th} meteorological week and the weekly minimum relative humidity of 46.1% was recorded in the afternoon of 3^{rd} & 8^{th} meteorological week (Table 3.1, Fig. 3.2). During the crop growing period, there was receipt of a meagre quantity 24.9 mm rainfall spreading over two rainy days. Maximum bright sunshine hour (7.5 day^{-1}) was recorded in the 50^{th} week coinciding with mid of December whereas the minimum bright sunshine hour (2.8 day^{-1}) was recorded in the 5th meteorological week of the year 2020. Maximum evaporation (3.7 mm) was recorded during 3rd and 8th meteorological week of the year. As detailed in table 3.1, the highest wind velocity was observed to be 0.9 km hr^{-1} during 1st and 6th meteorological week.

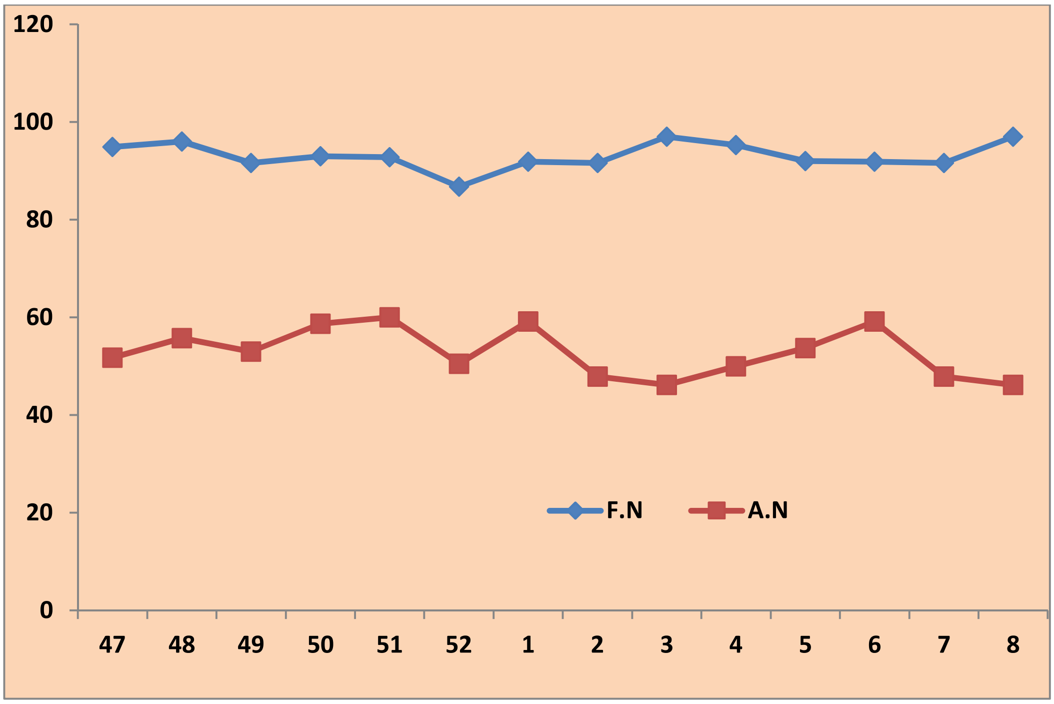
Table 3.1 Weekly meteorological data during crop growing season

Meteorological week no.	Standard week dates	Temperature (0^0 C)		Relative humidity (%)		Rainfall (mm)	Rainy days	Wind Velocity (km hr^{-1})	Evaporation (mm)	Bright sunshine hours (day^{-1})
		Max.	Min.	F.N	A.N					
47	19-25 Nov.	30.1	18.1	94.9	51.7	0.0	0.0	0.3	3.3	6.8
48	26-02 Dec.	29.7	18.5	96.0	55.7	0.0	0.0	0.3	3.4	5.0
49	03-09 Dec.	29.1	16.9	91.6	53.0	0.0	0.0	0.4	3.5	6.3
50	10-16 Dec.	30.4	18.1	93.0	58.7	0.0	0.0	0.1	3.6	7.5
51	17-23 Dec.	27.3	16.4	92.8	60.0	0.0	0.0	0.7	3.6	4.2
52	24-31 Dec.	26.1	13.2	86.8	50.5	0.0	0.0	0.6	3.5	4.1
1	01-07 Jan.	24.3	15.4	91.9	59.1	12.2	1.0	0.9	3.3	4.5
2	08-14 Jan.	26.9	13.8	91.6	47.9	0.0	0.0	0.4	3.5	6.0
3	15-21 Jan.	29.8	16.4	97.0	46.1	0.0	0.0	0.2	3.7	7.0
4	22-28 Jan.	29.4	16.5	95.3	50.0	0.0	0.0	0.4	3.5	6.2
5	29-04 Feb.	28.7	19.1	92.0	53.7	0.5	0.0	0.7	3.6	2.8
6	05-11 Feb.	24.3	15.4	91.9	59.1	12.2	1.0	0.9	3.3	4.5
7	12-18 Feb.	26.9	13.8	91.6	47.9	0.0	0.0	0.4	3.5	6.0
8	19-25 Feb.	29.8	16.4	97.0	46.1	0.0	0.0	0.2	3.7	7.0



Meteorological week

Fig. 3.1. Average weekly temperature (^{0}C)



Meteorological week

Fig. 3.2. Average weekly relative humidity (%)

3.4 Soil characteristic

For collection of soil samples, ten randomly selected spots were selected in zigzag manner representing the entire field. The samples were taken from the spots at a depth of 0 to 15 cm and were mixed thoroughly. Then a composite sample was prepared to determine its mechanical as well as other properties after analysis. The textural class of the experimental site was sandy loam and it was well-drained. The soil was acidic in nature with pH value of 5.72. It was medium in available nitrogen, phosphorus and potassium. The details are presented in the following tables.

Table 3.2 Mechanical composition of the soil

Soil fraction	Composition (%)	Method adopted
Sand	73.4	Bouyoucos Hydrometer method (Piper,1950)
Silt	10.2	
Clay	16.4	
Textural class	Sandy loam	

Table 3.3 Chemical properties of the soil

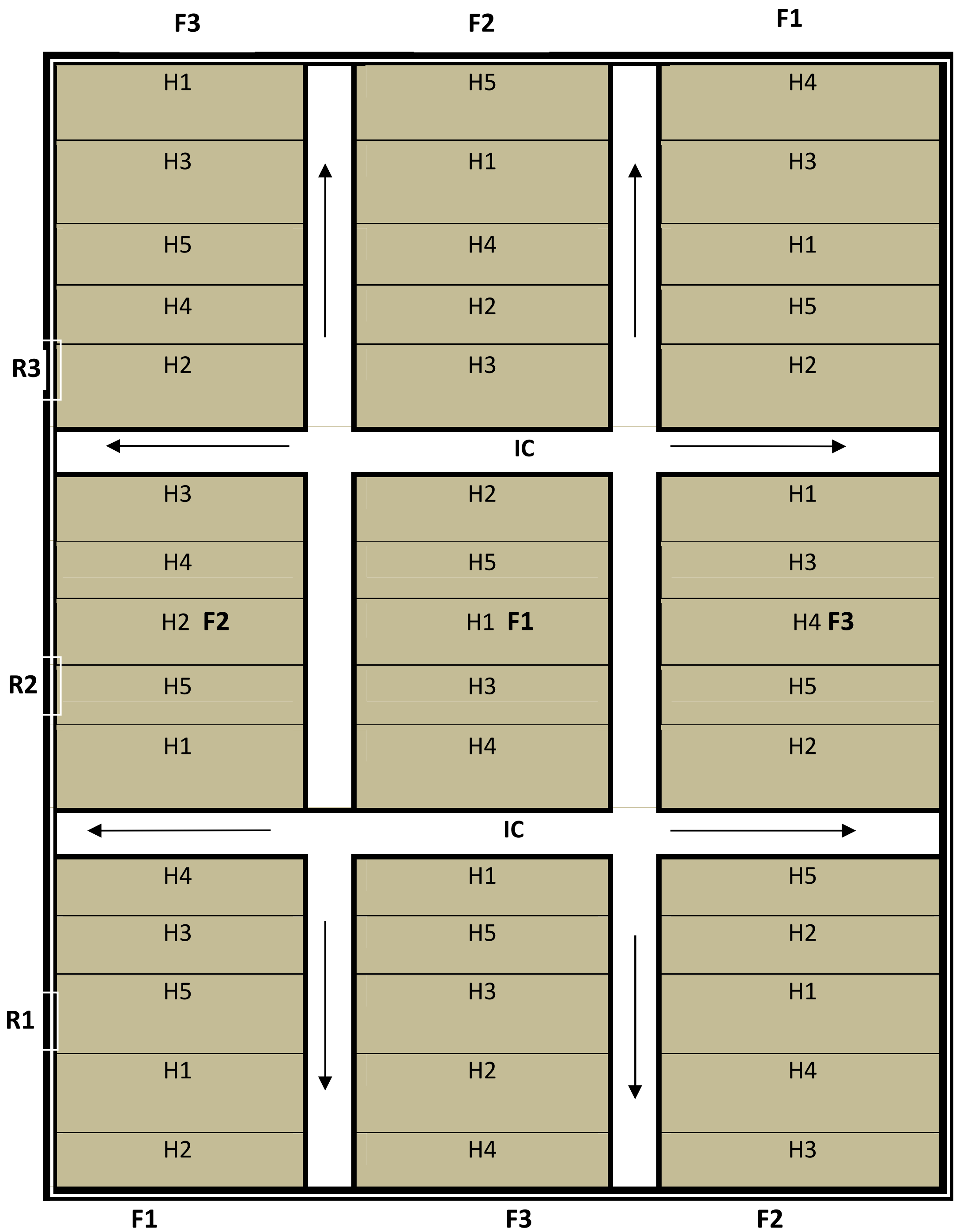
Properties	Value obtained	Method of analysis
pH(1:2.5 :: soil: water)	5.72	pH meter (Jackson, 1967)
Organic carbon	0.48	Modified Walkley and Black (Jackson, 1967)
Available N (kg ha^{-1})	266.40	Alkaline potassium permanganate (Subbiah and Asija, 1956)
Available P (kg ha^{-1})	18.42	$NaHCO_3$ extractable P (Jackson, 1967)
Available K (kg ha^{-1})	138.76	Ammonium acetate extraction (Jackson, 1967)
Electrical conductivity (dsm^{-1})	0.149	Conductivity meter (Jackson, 1967)

3.5. Cropping history

During last three years, various crops were taken in the experimental plot. The details of the crops are given in Table 3.4.

Table 3.4 Cropping history of experimental field

Year	Season		
	Kharif	Rabi	Summer
2016-17	Maize	Mustard	Fallow
2017-18	Maize	Mustard	Fallow
2018-19	Maize	Tomato	Fallow


F3
F2
F1
H1
H3
H5
H4
H2
H5
H1
H4
H2
H3
H4
H3
H1
H5
H2
R3
IC
H3
H4
H2 F2
H5
H1
H2
H5
H1 F1
H3
H4
H1
H3
H4 F3
H5
H2
R2
IC
H4
H3
H5
H1
H2
H1
H5
H3
H2
H4
H5
H2
H1
H4
H3
R1
F1
F3
F2
N

Lay out Plan

3.6 Experimental details

The experimental design of split plot was used to take up the experiment work. The treatments were replicated thrice in the field and the experiment was in the rabi season of 2019-20. There were three main plots and five sub plots having plot size of 21.78 m^2.

Treatment details

Main Plot: **Fertilizer level**

F_1=40:20:20 $N:P_2O_5:K_2O$ kg ha^{-1}

F_2=80:40:40 $N:P_2O_5:K_2O$ kg ha^{-1}

F_3=120:60:60 $N:P_2O_5:K_2O$ kg ha^{-1}

Sub Plot: Time of Harvest

Sub plot	Days after silking
H_1	16
H_2	20
H_3	24
H_4	28
H_5	32

3.7. Varietal characteristics

The sweet corn hybrid "Sugar 75" has good plant vigour and it grows up to a height of 1.8 meter. This hybrid is suitable to be grown in various states of the country in all the seasons. The hybrid is having maturity duration of 80-85 days and is having good yield potential under optimum management condition. The cobs are long and cylindrical with golden yellow coloured kernels. It is a delicious table variety having brix value of about 15-16%.

3.8. Field operation

3.8.1. Land preparation

Before taking up the crop, the plot was ploughed twice followed by levelling to get a good seed bed for facilitating germination. The field was cleaned by removing the weeds and crop residues. The calendar of operation is presented in the Table 3.5.

Table 3.5 Calendar of operation

Sl. No	Operation	Date of operation
1	Ploughing and leveling	22.11.2019
2	Layout	23.11.2019
3	Basal application of fertilizer and sowing	23.11.2019
4	Thinning and gap filling	3.12.2019
5	Hoeing, weeding, first top dressing and earthing up	17.12.2019
6	Second top dressing	07.01.2020

3.8.2. Seed treatment and sowing

The seeds were treated with carbendazim 50 WP @ 1.5 g kg^{-1} of seed. There was opening of furrow at row to row spacing of 60 cm. Sowing was done with the spacing of 25 cm in the furrow at a planting depth of 4 to 5 cm below the soil.

3.8.3. Fertilizer application

Prior to sowing, depending on the treatment requirements, the basal fertilizer was applied in the furrow. All phosphorus & potassium and 25 per cent of nitrogen were applied as basal fertilizer through Urea (46% N), Single Super Phosphate (16% P_2O_5) and Muriate of Potash (60 % K_2O). As per treatment requirement, half of nitrogen was given to the crop at first top dressing at 25 days after sowing. Rest 25 per cent of nitrogen, as per treatment, was applied at 45 days after sowing as second top dressing coinciding with early tasseling stage.

3.8.4. Irrigation

The field was irrigated just after sowing. Subsequently, light irrigation was given 10 days after sowing to loosen the soil for facilitating thinning and gap filling operation. Subsequently, irrigation was given as per the requirement of the crop.

3.8.5. Harvesting

The green cobs were harvested as per the treatment requirement. The green cobs were broken manually to harvest the crop. Ten plants were collected separately to take up post harvest observations.

3.9. Pre-harvest observations

At each net plot, 10 plants were chosen. The selected plants were tied with levels for taking observation on biometric characteristics. The plant height and leaf count were taken periodically, after 30, 45 and days of sowing. For taking such observation, 2 plants were removed from every plot at each of the above stages.

3.9.1 Plant height

The height of the plant was considered from the ground level to the base of top most leaf before flowing. But after emergence of silk, the height was taken by measuring the plant from the ground level to the base of tassel.

3.9.2 Leaf area index (LAI)

The physiologically active leaves were counted from ten plants and the average was calculated. The apparent leaf area was calculated by multiplication of the length with the width of three leaves taken from the above, middle and lower parts of the plants. The average was determined to obtain the area per leaf. The actual leaf area was determined by putting the leaf on a graph paper. The correction factor was ascertained by dividing the actual leaf area taken on the graph paper by apparent leaf area calculated from the length and width of the leaves. The actual leaf area was calculated by using the formula given below.

$$\text{Correction factor} = \frac{\text{Actual leaf area traced on graph}}{\text{Apparent leaf area}}$$

Actual leaf area = Apparent leaf area X correction factor

Total leaf area = Actual leaf area (cm^2) x number of leaves per plant

$$\text{Leaf area index} = \frac{\text{Total leaf area } (cm^2 plant^{-1})}{\text{Land area occupied } (cm^2 plant^{-1})}$$

3.9.3. Dry matter accumulation

The quantity of dry matter production was determined by taking plants from the border line of each plot. Then there was sun drying of the plants. Subsequently, the plants were oven dried for 24 hours at a temperature of 65^0C to obtain the dry weight. The average value of dry matter accumulation was calculated.

3.9.4. Crop growth rate

Crop growth rate (CGR) was calculated by the formula given below (Radford, 1967).

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \text{ (g m}^{-2}\text{ day}^{-1})$$

where, W_1 and W_2 = total dry weight (g m^{-2}) at time t_1 and t_2 respectively.

3.9.5. Relative growth rate

The Relative growth rate (RGR) was calculated by the following formula.

$$RGR = \frac{l_n W_2 - l_n W_1}{t_2 - t_1} \text{ (g g}^{-1}\text{ day}^{-1})$$

where, W_1 and W_2 = total dry weight (g $plant^{-1}$) at time t_1 and t_2 respectively.

3.9.6. Physiological stages of the crop

The plants of two middle rows were selected to determine time taken for emergence of 50 per cent tassel and silk. The day on which there was appearance of 50 per cent tassel or emergence of 50 per cent silk in the plot was recorded and was taken as days taken for fifty per cent tasselling or fifty per cent silking, respectively. The silking date was recorded by counting the cobs having 2-3 cm long silk.

3.10 Post-harvest studies

3.10.1. Cob length and girth

There was random selection of ten cobs from every plot. Subsequently, the length and girth of cobs were measured.

3.10.2. Cob weight

Ten cobs were randomly selected from each plot. The weight of the cobs with husk cover and without husk cover was taken separately and the mean was calculated.

3.10.3. Number of kernels per cob

There was counting of row number in a cob and the number of filled grains or kernel in the row. The number of row was multiplied by the no. of grain per cob to obtain the no. of kernels per cob.

3.10.4. Hundred kernel weight and kernel recovery

The kernels from ten sample cobs were carefully separated and weighed. The average was worked out. Percentage of recovery was obtained by dividing average kernel weight with average weight of cob and multiplied by 100. The weight of 100 kernel was also recorded.

3.10.5. Green cob yield

For taking this observation, the green cobs from each plot were weighed. The hectare factor was multiplied with the observed weight to obtain the yield per hectare.

3.10.6. Green fodder yield

The plants were taken from the ground after harvest of green cob. After that the net plot yield was multiplied by hectare factor to obtain yield per hectare.

3.10.7. Fresh kernel yield

The cob weight obtained from the net plot was multiplied with the kernel recovery percentage. The result was divided by 100. Then it was multiplied with hectare factor to obtain fresh kernel yield.

3.10.8. Harvest Index (HI)

The following formula was used to calculate Harvest Index (HI) and it was expressed in percentage.

HI=Economic yield (fresh weight of cobs)/ Biological yield (sum of cob and stover yield) X 100

3.11 Chemical analysis

3.11.1 Nutrient content

The samples of plants taken from the experiment field at the time of harvest were oven dried. Then those are analysed for calculating uptake of plant nutrients viz., nitrogen, phosphorus and potash. Then the oven dried samples were processed for final grinding. Those were passed through a sieve with 2 mm diameter and analysis was done by the following methods.

Sl. No.	Nutrient	Method
1.	Total nitrogen	Modified Micro-Kjeldahl's method (Jackson, 1967)
2.	Total phosphorus	Di-acid digestion method and colourimetric determination (Piper,1950)
3.	Total potassium	Flame photometer method (Jackson, 1967)

3.11.2 Removal of plant nutrients

The removal of various nutrients such as nitrogen, phosphorus and potash either by grain or stover were determined. This was performed by multiplication of the yield and content of respective nutrients in the grain or stover on dry weight basis. There was calculation for the total nutrient uptake (such as nitrogen, phosphorus and potash) through adding the quantity of nutrients taken up by the grain and the stover.

3.11.3 Protein content

There was calculation of the quantity of protein present in the kernel by multiplication of the factor 6.25 with the content of nitrogen in the kernel.

3.11.4. Total soluble sugar

The Anthrone method was utilized for determination of total soluble sugar content of the kernel. Sugar extract of kernel was taken and volume make-up was done with 80% ethanol. The diluted sample was taken in a test tube and kept in ice-bath. Anthrone reagent was added to it. After stirring, the test tubes were put the container with boiling water. Then those were cooled in a container with ice. There was measurement of OD at a value of 630 nm. The standard curve was used to measure the total sugar content of kernel.

3.12 Economics of cultivation

The prevailing market price of the inputs was considered for calculation of cost of cultivation of sweet corn. The cost of green cob and green fodder was taken as Rs 10,000 and Rs 200 per tonne, respectively to calculate the gross return. The net profit and benefit-cost ratio were calculated by obtaining the difference and quotient between gross return and cost incurred for cultivation, respectively.

3.13 Statistical analysis

The observations taken at different stages were analysed statistically to derive various inferences. The analysis was done in the technique of standard analysis of variance as mentioned by Gomez and Gomez (1984). The SEm± (standard error mean) and the CD (critical difference) were taken at a level of 5 per cent significance.

RESULTS

In this chapter, the observations recorded during the investigation are presented after statistical analysis.

4.1. Pre-harvest studies

4.1.1. Height of the plant

The height of the plant increased in an accelerated manner till 60 days after sowing (DAS) and the rate of growth was slow down subsequently. Application of N, P_2O_5 and K_2O @ 120, 60 and 60 kg ha^{-1} produced the tallest plants of 59.2 cm height at 30 DAS. Of course, it was statistically at par with the fertility level of 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. The dwarfest (44.2 cm) plants were produced in the plots provided with 40 kg N, 20 kg P_2O_5 and 20 kg K_2O per hectare.

Table 4.1 Effect of levels of fertilizer and harvesting date on height of plant (cm)

Treatments	30 DAS	45 DAS	60 DAS	At harvest
Main plot				
F_1	44.2	75.1	137.8	160.0
F_2	57.1	87.3	152.1	179.6
F_3	59.2	91.7	152.8	183.7
SE(m) $\pm$	1.99	1.82	5.62	12.13
CD (0.05)	7.82	7.14	NS	NS
Sub plot				
H_1	52.1	83.7	146.3	165.20
H_2	53.2	83.7	151.8	180.18
H_3	53.5	85.8	143.2	177.61
H_4	54.0	84.8	150.4	173.40
H_5	54.6	85.5	146.1	175.89
SE(m) $\pm$	0.98	0.96	4.03	7.06
CD (0.05)	NS	NS	NS	NS

Similar trend was observed at 45 DAS where tallest plants (91.7 cm) were observed in the treatment F_3 with the highest level of fertility i.e. 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}. This was statistically similar with the fertility level of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare (Table 4.1 and Fig. 4.1). Variation in fertilizer application did not affect plant height significantly after 60 days of sowing. Date of harvesting did not influence the height of the plants at different growth stages. There was no interaction effect of fertility level and harvesting date on plant height at any of the growth stages.

Table 4.2 Effect of fertility level and harvesting date on leaf area index

Treatments	**30 DAS**	**45DAS**	**60 DAS**	**At harvest**
Main plot				
F_1	1.24	2.29	3.77	4.02
F_2	1.33	2.84	3.90	4.03
F_3	1.38	2.88	4.02	4.24
SE(m)$\pm$	0.023	0.125	0.042	0.056
CD (0.05)	0.90	0.490	0.167	NS
Sub plot				
H_1	1.35	2.65	3.99	4.18
H_2	1.26	2.65	3.88	4.05
H_3	1.32	2.55	3.82	4.07
H_4	1.32	2.79	3.82	3.91
H_5	1.34	2.72	3.99	4.28
SE(m)$\pm$	0.049	0.114	0.122	0.111
CD (0.05)	NS	NS	NS	NS

4.1.2 Leaf area index

There was rapid increase in leaf area index (LAI) till 60 DAS after which the rate of increase was slow. The leaf area index was maximum (1.38) at 30 DAS with the highest level of fertilizer application. This was statistically similar with the fertility level of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O ha^{-1} (1.33). The leaf area index was the minimum (1.24) with the lowest level of fertility. Similarly, the leaf area index was the maximum (2.88) with the highest level of fertility i.e. 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} at 45 DAS. Although, this was superior over the lowest level of fertilizer application i.e. 40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1}. At 60 DAS, the leaf area index recorded the highest (4.02) with the maximum quantity of fertilizer application. It was significantly higher than the LAI obtained with the lowest level of fertility. There was no significant effect of different levels of fertilizer application on leaf area index at harvest (Table 4.2, Fig. 4.2).

The date of harvest did not affect leaf area index at any stage of growth. The interaction effect of fertility level and harvest date was not significant with respect to leaf area index.

4.1.3 Accumulation of dry matter

Accumulation of dry matter increased rapidly up to 60 days after sowing (DAS). The highest quantity of dry matter was accumulated (169.1 g m^{-2}) with application of $N:P_2O_5:K_2O$ @ 120:60:60 kg ha^{-1} at 30 DAS. This was statistically superior to application of other levels of fertility. Similar results were observed at 45 DAS and 60 DAS with the highest dry matter production of 333.2 g m^{-2} and 548.1 g m^{-2}, respectively with the highest level of fertility (F_3). The value was significantly higher than that obtained from other levels of fertility (Table 4.3, Fig. 4.3). There was no significant difference among different fertility levels at harvest with respect to dry matter production. There was no significant effect of harvesting date on dry matter production up to 60 DAS. But, accumulation of dry matter was the minimum (744.4 g m^{-2}) at harvest when the crop was harvested at 16 days after silking. There was no interaction effect of fertility level and harvest date on production of dry matter at any of the growth stages.

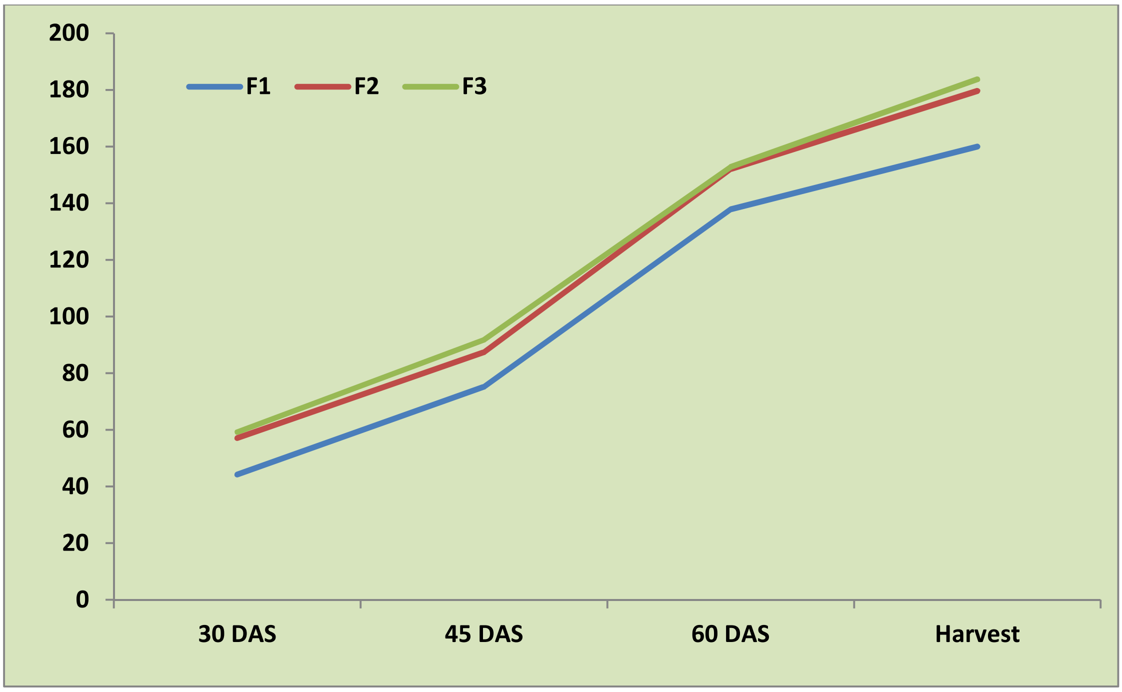


Fig 4.1 Effect of fertility level on plant height (cm)

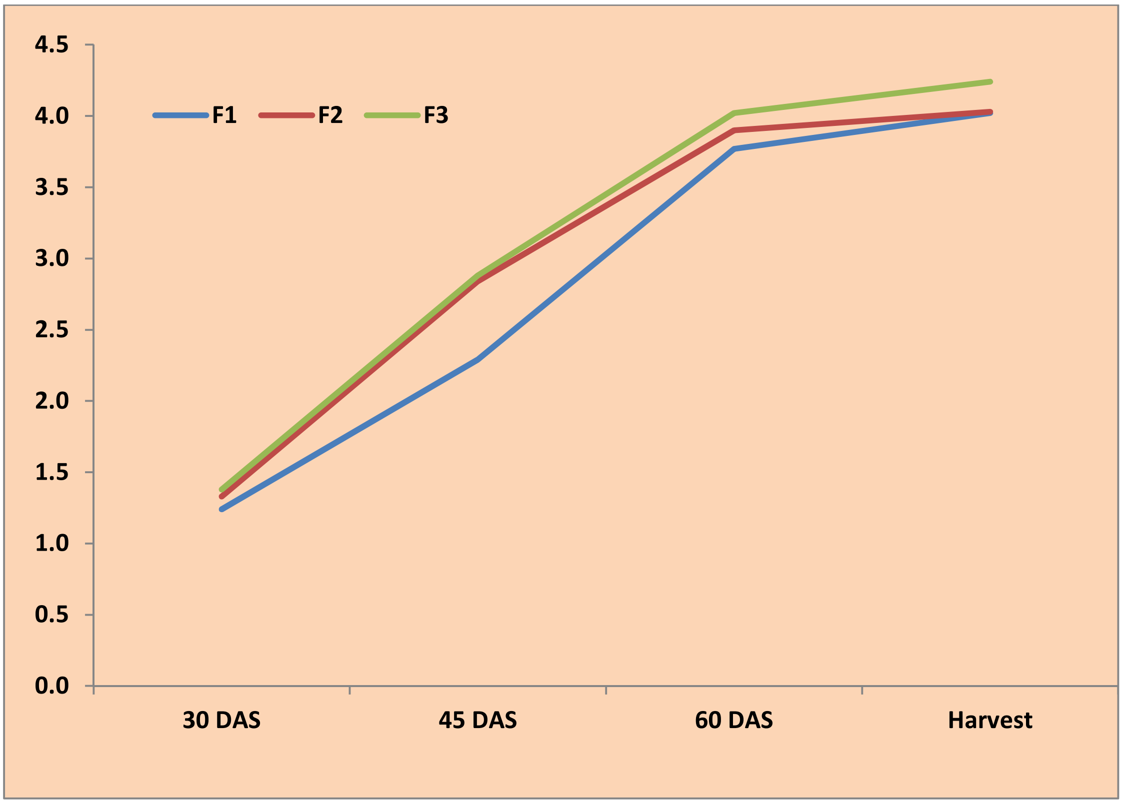


Fig 4.2 Effect of fertility level on leaf area index

Table 4.3 Effect of fertility level and harvest date on dry matter accumulation (g m^{-2})

Treatments	**30 DAS**	**45 DAS**	**60 DAS**	**At harvest**
Main plot				
F_1	121.0	263.3	504.3	764.4
F_2	151.1	288.8	536.0	817.3
F_3	169.1	333.2	584.1	853.0
SE(m) $\pm$	4.31	2.83	12.15	30.30
CD (0.05)	16.92	11.12	47.69	NS
Sub plot				
H_1	157.1	317.7	575.5	744.4
H_2	143.6	278.7	517.0	790.0
H_3	143.7	283.5	516.9	815.0
H_4	145.0	293.6	534.4	842.2
H_5	145.9	301.9	563.5	866.2
SE(m) $\pm$	4.64	9.94	19.99	25.06
CD (0.05)	NS	NS	NS	73.16

4.1.4. Crop growth rate

The crop growth rate or the CGR enhanced continuously till harvest. But, there was accelerated increase in crop growth rate till 60 DAS. There maximum growth of crop in between 30 and 45 DAS with application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} (10.94 g m^{-2} day^{-1}), which was statistically higher than the results obtained from other treatments. But subsequently, fertilizer application at different levels did not affect the crop growth rate significantly (Table 4.4 and Fig. 4.4).

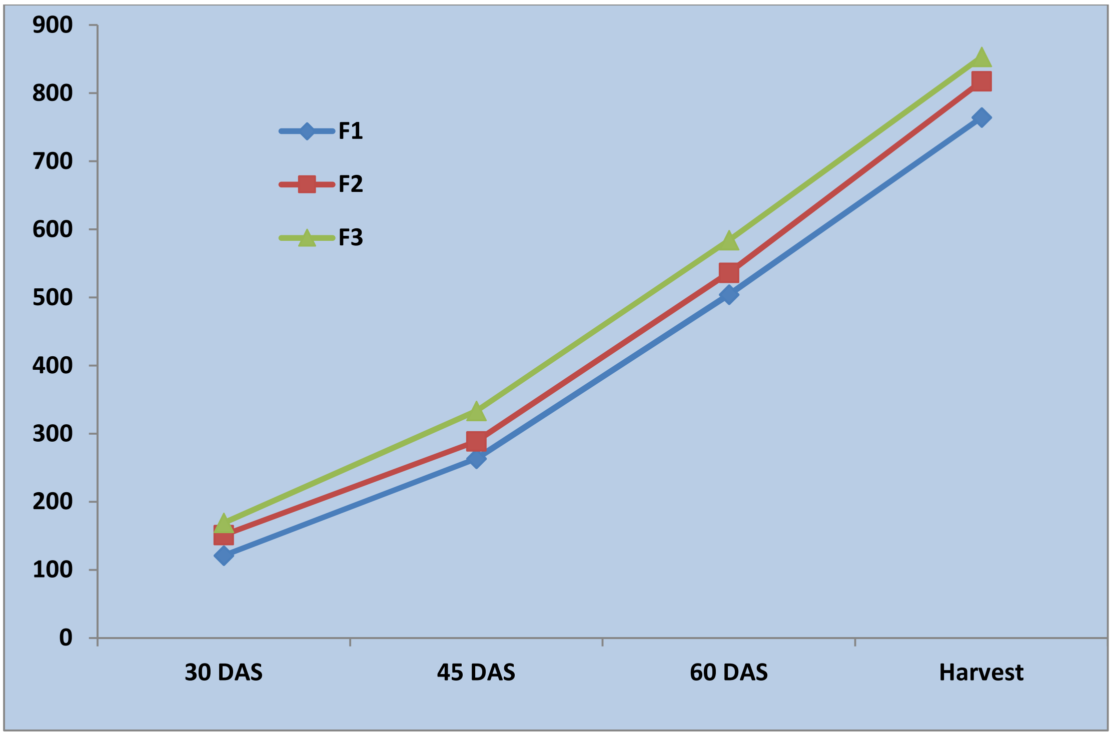


Fig 4.3 Effect of fertility level on accumulation of dry matter (g m^{-2})

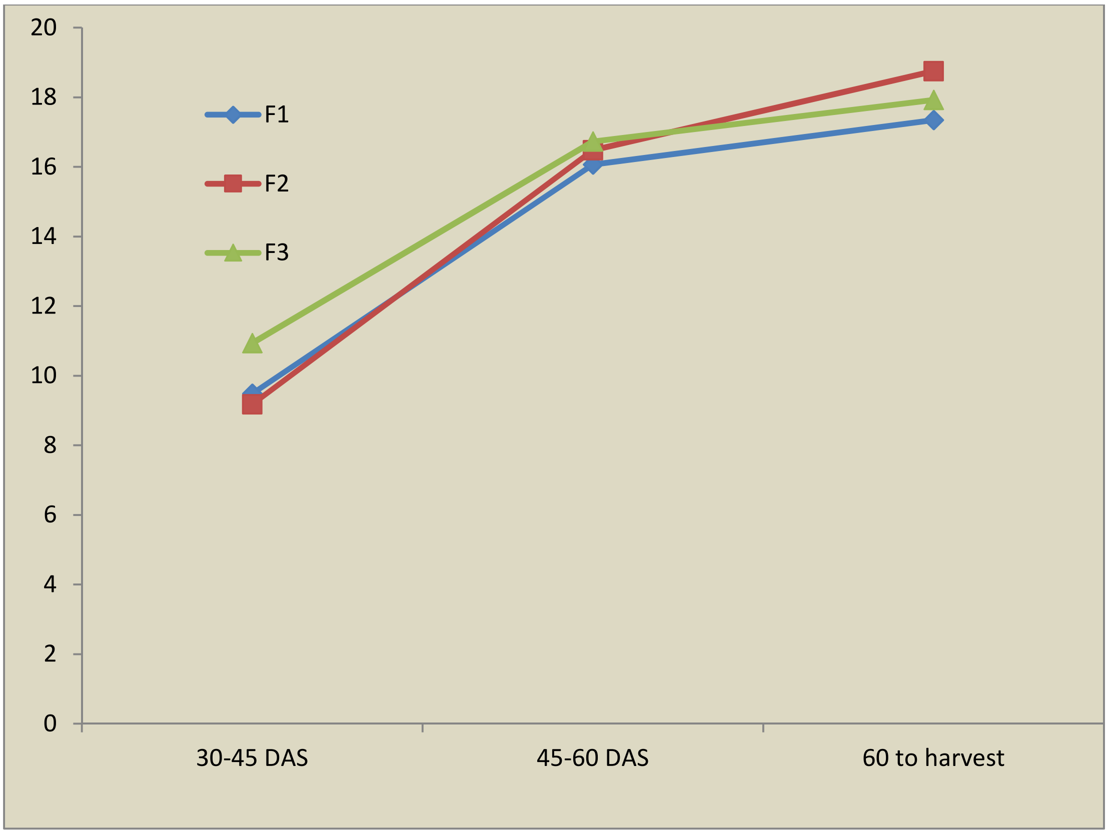


Fig. 4.4 Effect of the fertility level on crop growth rate (g m^{-2} day^{-1})

After 60 days of sowing till harvest, the growth rate of crops was significantly affected by date of harvest. The minimum value (11.26 g m^{-2} day^{-1}) of crop growth rate was obtained in the plots which were harvested at 16 days after silking. The interaction effect between levels of fertility and harvesting date was not significant with respect to rate of crop growth irrespective of stages of growth.

Table 4.4 Effect of levels of fertility and harvest date on CGR (g m^{-2} day^{-1})

Treatment	30-45 DAS	45-60 DAS	60 DAS to harvest
Main plot			
F_1	9.48	16.07	17.34
F_2	9.18	16.48	18.76
F_3	10.94	16.73	17.93
SE(m) $\pm$	0.231	0.701	1.675
CD (0.05)	0.908	NS	NS
Sub plot			
H_1	10.71	17.18	11.26
H_2	9.00	15.89	18.20
H_3	9.32	15.56	19.87
H_4	9.91	16.05	20.52
H_5	10.40	17.44	20.18
SE(m) $\pm$	0.478	0.786	1.705
CD (0.05)	NS	NS	4.975

4.1.5. Relative growth rate

There was decrease in the relative growth rate (RGR) of crops with progress of the crop stages. During 30-45 DAS, the RGR was the highest with lowest level of fertilizer application (40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1}) as in case of treatment F_1 (0.022 g g^{-1} day^{-1}). This was statistically similar with the treatments receiving the highest level of fertilizer (0.020 g g^{-1} day^{-1}). There was no significant effect of variation in fertilizer application after 45 days of sowing (Table 4.5).

After 60 days of sowing, the date of harvest significantly affected the relative growth rate of the crop. The crop harvested at 16 days after silking resulted the minimum RGR of 0.007 g g^{-1} day^{-1} in the period between 60 DAS and harvest. The interaction effect of variation in fertilizer application and the date of harvest was not found significant with respect to RGR at different growth stages of the crop.

Table 4.5. Effect of fertility level and harvest date on RGR (g g^{-1} day^{-1})

Treatments	**30-45 DAS**	**45-60 DAS**	**60 DAS till harvest**
Main plot			
F_1	0.022	0.019	0.012
F_2	0.019	0.018	0.012
F_3	0.020	0.016	0.011
SE(m) $\pm$	0.0007	0.0005	0.0008
CD (0.05)	0.0026	NS	NS
Sub plot			
H_1	0.021	0.017	0.007
H_2	0.019	0.018	0.012
H_3	0.020	0.017	0.013
H_4	0.021	0.017	0.013
H_5	0.021	0.18	0.13
SE(m)$\pm$	0.0007	0.0005	0.0011
CD (0.05)	NS	NS	0.0031

4.1.6. Physiological stages

Tasseling and silking was statistically affected by levels of fertilizer application. Days taken to fifty per cent tasseling was the minimum (50.7) with the highest level of fertility (F_3). There was requirement of maximum days (52.3) for tasseling with the highest fertility level in treatment F_3. Similarly, silking was delayed with application of less quantity of chemical fertilizer. The treatment F_3 receiving maximum fertilizer required minimum days (54.1) for emergence of 50% silk. However, the time taken for silking was the maximum of 57.2 days with treatment F_1 receiving lowest level of fertility (Table 4.6).

Date of harvest did not affect the days to tasseling or days taken for silking. No significant interaction effect between fertility level and harvest date was noticed on days taken for tasseling or days taken for silking.

Table 4.6 Effect of fertility level and harvest date on days taken for tasseling and silking

Treatment	Days to 50 % tasseling	Days to 50 % silking
Main plot		
F_1	52.3	57.2
F_2	51.7	54.9
F_3	50.7	54.1
SE(m) $\pm$	0.28	0.27
CD (0.05)	1.09	1.04
Sub plot		
H_1	51.6	55.3
H_2	50.6	54.6
H_3	51.6	55.3
H_4	51.4	55.7
H_5	52.6	56.2
SE(m) $\pm$	0.56	0.73
CD (0.05)	NS	NS

4.2. Post harvest studies

4.2.1. Plant population

There was no effect of fertilizer application or time of harvest on the plant population. However, the highest plant count was recorded as 65,800 per hectare in the treatment F3 receiving maximum quantity of fertilizer (Table 4.7). But, this was not statistically superior over other levels of fertility. Regarding date of harvest, the maximum plant population of 65.96 thousand ha^{-1} was realized in treatment H_5, which was at par with other treatments.

Table 4.7 **Effect of the fertility level and harvest date on plant stand and cob count**

Treatment	Plant stand at harvest ('000 ha^{-1})	No. of cobs ('000 ha^{-1})
Main plot		
F_1	63.39	71.47
F_2	63.97	76.27
F_3	65.80	76.91
SE(m) ±	1.114	0.761
CD (0.05)	NS	2.987
Sub plot		
H_1	64.27	73.61
H_2	63.66	74.63
H_3	64.94	74.22
H_4	63.10	75.96
H_5	65.96	76.01
SE(m) ±	1.328	1.171
CD (0.05)	NS	NS

4.2.2 Number of cobs

The production of green cob was significantly affected by variation in fertility levels. It was observed that the highest number of 76,910 cobs per hectare was produced with application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}. This was statistically comparable with the treatment F_2 (76.27 thousand cobs ha^{-1}). But, both the treatments were superior over the plots receiving lowest level of fertilizer in treatment F_1. There was no significant effect of various harvesting dates on cob number (Table 4.7).

4.2.3 Cob length

Variation of fertility level and time of harvest significantly affected the length of the cob. The longest cobs (29.9 cm) were produced in the treatment F_3 receiving the highest level of fertility, which was statistically similar (29.5 cm) with the treatment F_2. But, it was superior to fertility level of 40:20:20 kg $N:P_2O_5:K_2O$ ha^{-1} (27.9 cm). The length of cob did not increase significantly when those were harvested beyond 24 days after silking. However, the longest cobs (30.8 cm) were recorded when the crop was harvested at 32 days after silking (Table 4.8).

4.2.4 Cob girth

Fertility level and date of harvest significantly affected the girth of cob. The maximum cob girth (16.5 cm) was recorded with application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} in case of treatment F_3. Statistically, it was better than other levels of fertility. The thickest cob (19.1 cm) was harvested at 32 days after silking. Harvesting the crop at 16 days after silking produced cobs with the minimum girth of 13.6 cm (Table 4.8).

4.2.5 Cob weight

Fertilizer application and date of harvesting significantly affected the weight of the cob with husk. The heaviest husked cob (349.9 g cob^{-1}) was observed with application of the highest level of fertilizer (F_3). However, this was statistically comparable with the fertility level of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare (346.6 g cob^{-1}). The weight of cob with husk increased steadily up to 28 days after silking, but decreased when harvested at 32 days of silking. The heaviest husked cob (371.2 g cob^{-1}) was observed at 28 days of silking which was statistically similar with the treatments harvested at 24 or 32 days after silking (Table 4.8).

The results obtained regarding the weight of the green cob without husk followed the similar trend as that of cobs with husk. The heaviest dehusked cobs (213 g cob^{-1}) were recorded in the crop receiving highest level of fertilizer in treatment F_3. It was not significantly higher that the plot getting fertilizer dose of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare (212.6 g cob^{-1}). Progress in date of harvest enhanced the weight of dehusked cob with its maximum value of 233 g cob^{-1} at harvesting at 32 days after silking. This was at par with the results obtained from the plots harvested at 24 or 28 days after silking (Table 4.8).

Table 4.8. Effect of levels of fertility and the harvest date on cob size and cob weight

Treatment	Length of cob (cm)	Girth of cob (cm)	Weight of cob with hush (g)	Weight of dehusked cob (g)
Main plot				
F_1	27.9	16.0	314.8	176.1
F_2	29.5	16.3	346.6	212.6
F_3	29.9	16.5	349.9	213.0
SE(m) $\pm$	0.23	0.05	5.57	4.75
CD (0.05)	0.90	0.20	21.87	18.65
Sub plot				
H_1	27.1	13.6	254.1	134.7
H_2	27.9	14.5	334.1	189.9
H_3	29.5	16.1	360.8	212.5
H_4	30.2	18.0	371.2	232.7
H_5	30.8	19.1	365.2	233.0
SE(m) $\pm$	0.63	0.12	9.68	7.32
CD (0.05)	1.85	0.35	28.26	21.37

4.2.6. Fresh weight of kernel

The weight of freshly harvested grain or kernel was significantly affected by variation in fertilizer application. Heaviest kernel (32.7 g per 100) was recorded in the treatment receiving maximum quantity of fertilizer in treatment F_3. This was not significantly better that the treatment receiving 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare (32.0 g per 100). It to be mentioned that minimum weight (30.3 g per 100) of freshly harvested kernel was recorded with the fertility level of 40 kg N, 20 kg P_2O_5 and 20 kg K_2O per hectare. There was enhancement in weight of fresh grain with progress of harvesting date. Heaviest kernels (33.8 g per 100) were obtained by harvesting at 32 days of silking, which was at par with the kernels harvested at 24 days (32.6 g per 100) and 28 days (33.4 g per 100) after silking.

Table 4.9. Effect of fertility level and harvest date on weight, count and recovery of kernels

Treatment	Fresh kernel weight (g per 100)	Kernels per cob	Kernel recovery (%)
Main plot			
F_1	30.3	336.9	37.6
F_2	32.0	345.9	37.7
F_3	32.7	352.4	37.3
SE(m) ±	0.29	10.40	0.45
CD (0.05)	1.13	NS	NS
Sub plot			
H_1	28.4	292.3	34.5
H_2	30.2	323.9	37.5
H_3	32.6	365.1	38.1
H_4	33.4	372.4	38.7
H_5	33.8	371.5	38.7
SE(m) ±	0.75	12.06	0.72
CD (0.05)	2.20	35.21	2.11

4.2.7. Number of kernel per cob

Fertilizer application did not affect the number of kernel per cob. However, the maximum number of kernel (352.4 kernel cob^{-1}) was recorded by providing maximum quantity of fertilizer in treatment F_3. Harvesting date had significant influence on the kernel count. There was the maximum number of kernels (372.4) per cob when harvested 28 days after silking, which was statistically comparable with the treatments harvested at 24 days or 32 days after emergence of silk.

4.2.8. Kernel recovery percentage

Maximum recovery of 37.7 per cent was recorded with the fertility level of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare. There was increase in recovery percentage with the progress of harvesting date up to 28 days after silking. Similar value of kernel recovery (38.7%) was recorded when harvested at 28 or 32 days after silking. It was statistically at par with kernel recovery per cent recorded at 20 or 24 days after silking.

4.2.9. Green cob yield

Fertilizer application has significant effect on yield of green cob. Application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} produced the maximum quantity (15.63 t ha^{-1}) of green cob (Table 4.10). Minimum green cob yield of 12.66 t ha^{-1} was obtained with the minimum fertility level of 40:20:20 kg N:P_2O_5:K_2O ha^{-1}. The yield of green com increased with progress of date of harvest. There was maximum yield (15.89 t ha^{-1}) of green cob from the treatments harvested at 32 days after silking, of course statistically comparable with yield obtained at 24 and 28 days after silking. The treatments harvested at 16 days after silk emergence produced minimum quantity (11.88 t ha^{-1}) of green cob.

The interaction effect of levels of fertility and harvesting date on yield of green cob was significant (Table 4.11). Treatments provided with 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare and harvested at 32 days after silking resulted in maximum green cob yield of 17.62 t ha^{-1}. It was comparable with the green cob yield obtained from the treatments receiving 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare and harvested at 24 or 28 days after silking or the treatments receiving 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare and harvested at 28 or 32 days after silking (Table 4.11).

4.2.10 Green fodder yield

There was enhancement in the yield of fodder due to increase in fertility level. Maximum green fodder yield of 36.42 tonne per hectare was realized in the treatment F_3 provided with 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} (Table 4.10). This was at par with the fodder yield (35.15 t ha^{-1}) obtained from the treatments receiving 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. Minimum yield of 28.26 tonne green fodder per hectare was recorded in the treatment F_1 provided with minimum quantity of fertilizer. The progress in harvesting date continuously enhanced the yield of green fodder. Harvesting the crop at the latest date (32 days after silking) produced maximum of 34.88 tonne green fodder per hectare, which was statistically similar with the yield obtained when the crop was harvested at 20 or 24 or 28 days after silking. There was no significant effect of the levels of fertilizer application and harvesting date on yield of green fodder.

4.2.11. Fresh kernel yield

Yield of fresh kernel was significantly affected both by fertility level and harvest date. Application of maximum quantity of fertilizer in case of F_3, yielded maximum fresh kernel (7.86 t ha^{-1}), which was statistically superior to other levels of fertility. The fresh kernel yield was the minimum (6.84 t ha^{-1}) in the crops of treatment F_1 receiving lowest quantity of fertilizer. The yield of fresh kernel enhanced linearly with enhancement of days taken for harvesting after emergence of silk (Table 4.10). Harvesting at 32 days after silking resulted in yield of the maximum quantity of fresh kernel (8.07 t ha^{-1}).

There was significant interaction effect of the levels of fertility and harvesting date on yield of fresh kernel. The treatments provided with 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare and harvested at 32 days after silking produced maximum kernel of 8.74 t ha^{-1}. Of course, this was statistically similar with the yield obtained from treatments harvested at 24 or 28 days after silking with same level of fertilizer application or harvesting at 28 or 32 days after silking with application of 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare (Table 4.12).

Table 4.10 Effect of levels of fertility and harvest date on yield of green cob, fodder and kernel

Treatments	Yield of green cob (t ha^{-1})	Yield of green fodder (t ha^{-1})	Yield of kernel (t ha^{-1})	Harvest index (%)
Main plot				
F_1	12.66	28.26	6.84	30.9
F_2	14.62	35.15	7.45	29.3
F_3	15.63	36.42	7.86	29.9
SE(m)±	0.242	0.433	0.079	0.51
CD (0.05)	0.951	1.700	0.311	NS
Sub plot				
H_1	11.88	30.80	6.11	27.9
H_2	12.94	32.53	6.97	28.6
H_3	15.22	33.49	7.82	31.2
H_4	15.59	34.69	7.95	31.1
H_5	15.89	34.88	8.07	31.4
SE(m)±	0.368	0.914	0.146	0.74
CD (0.05)	1.075	2.669	0.425	2.15

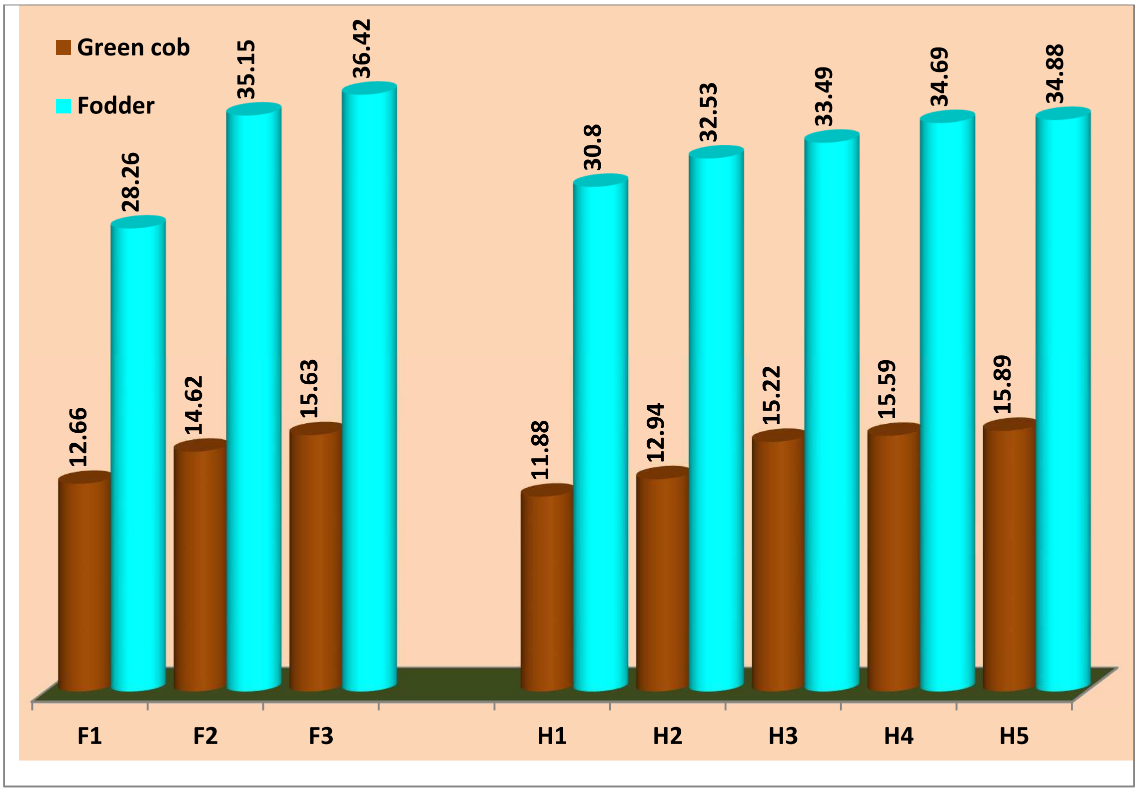


Fig. 4.5. Effect of levels of fertility and harvest date on yield of green cob and fodder (t ha^{-1})

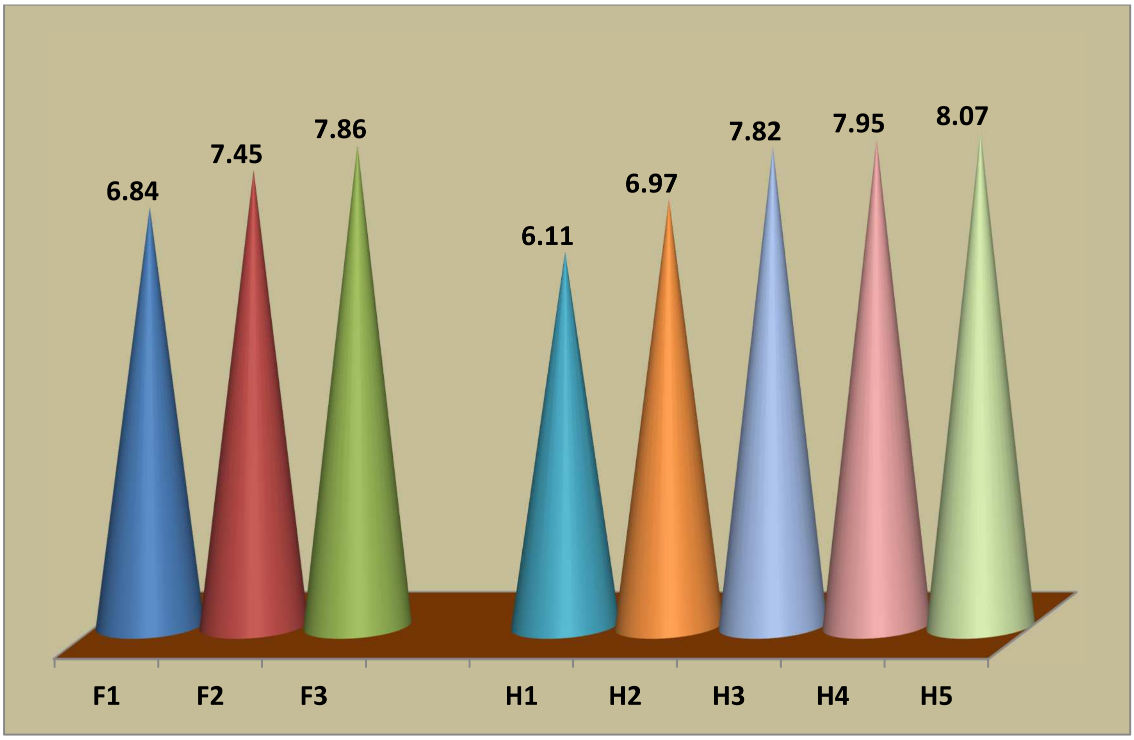


Fig.4.6. Effect of levels of fertility and harvest date on fresh kernel yield (t ha^{-1})

4.2.12 Harvest index

Variation in quantity of fertilizer application did not have any significant effect on the harvest index of the crop. However, the treatment with lowest fertility level resulted in maximum harvest index (30.9 %). It was statistically similar to other levels of fertilizer application. Harvesting date had significant affect on harvest index. The maximum harvest index of 31.4 % was obtained with harvesting at 32 days after silking. However, this was not significantly higher than the harvest index obtained from the treatments harvested at 24 or 28 days after silking (Table 4.10). Harvesting the crop at 16 days after silking recorded the minimum harvest index of 27.9 per cent.

Table 4.11 Interaction effect of levels of fertility and harvest date on yield of green cob (t ha^{-1})

Treatments	F_1	F_2	F_3
H_1	11.46	11.66	12.51
H_2	12.81	12.57	13.45
H_3	12.88	15.58	17.19
H_4	12.95	16.41	17.41
H_5	13.20	16.85	17.62
	H X F	F X H	
SE(m) $\pm$	0.638	0.494	
CD (0.05)	1.862	1.442	

Table 4.12 Interaction effect of levels of fertility and harvest date on yield of fresh kernel (t ha^{-1})

Treatments	F_1	F_2	F_3
H_1	5.95	6.07	6.32
H_2	7.25	6.68	6.99
H_3	6.98	7.74	8.74
H_4	7.09	8.26	8.51
H_5	6.93	8.52	8.74
	H X F	F X H	
SE(m) $\pm$	0.252	0.195	
CD (0.05)	0.736	0.570	

4.2.13 Total soluble sugar

Different levels of fertility did not influence the total soluble sugar content of the kernel significantly. Moreover, the soluble sugar content was the maximum with the treatment F_1 provided with minimum quantity of fertilizer. Of course, it was statistically similar with treatments receiving other levels of fertilizer (Table 4.13). The soluble sugar content of the kernel was significantly affected in variation in harvesting date. There was increase in sugar content of the kernel with progress of harvesting date after emergence of silk. The maximum total soluble sugar (12.9 %) was recorded in the treatments harvested 24 days after silk emergence. But it was statistically comparable with the crops harvested at 28 days after silk emergence. The significant effect of variation in fertilizer application and harvesting date was not observed on sugar content of the kernel.

Table 4.13 Effect of levels of fertility and harvest date on sugar content and protein content

Treatment	Total soluble sugar (%)	Protein content (%)
Main plot		
F_1	10.87	6.64
F_2	10.60	7.36
F_3	10.27	7.47
SE(m) $\pm$	0.243	0.145
CD (0.05)	NS	0.569
Sub plot		
H_1	7.7	6.98
H_2	8.9	7.03
H_3	12.9	7.10
H_4	12.7	7.31
H_5	10.8	7.35
SE(m) $\pm$	0.229	0.084
CD (0.05)	0.669	0.246

4.2.14. Protein content

Fertilizer application significantly affected the protein content of kernel. The treatment F3 receiving maximum quantity of fertilizer recorded maximum content of protein (7.47%). It was statistically comparable with the values obtained with application of 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare.

Minimum protein content of 6.64 per cent was recorded in F1 with lowest level of fertilizer application. Variation in harvesting date had significant influence on the protein contain of the kernel. Protein contain increased with the progress of the harvesting date.

Harvesting the crop at a later date i.e. at 32 days after silking resulted in maximum kernel protein content of 7.35 per cent (Table 4.13). However it was statistically similar with the protein content (7.31%) obtained from the plots harvested at 28 days after silk emergence. The significant effect of variation in fertilizer application and harvesting date was not observed on the protein content of the kernel.

4.3. Nutrient content

4.3.1. Nitrogen

Variation in fertility level significantly affected nitrogen content of both grain and straw. Maximum nitrogen content (1.20%) of grain could be realized in the treatment F_3 receiving the highest quantity of fertilizer, which was statistically comparable with application of 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. Minimum nitrogen content (1.06%) of grain was observed when $N:P_2O_5:K_2O$ were applied @ 40:20:20 kg per hectare. The maximum content of nitrogen (0.43%) was recorded with application of the highest level of fertility i.e. 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare. It was found to be statistically similar with the treatments receiving 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. The nitrogen content of the grain was significantly affected due to variation in dates of harvesting. The crops harvested after 32 days of silking had maximum nitrogen content of 1.18% in the grain (Table 4.14). But, this was not statistically superior to the crop harvested at 28 days after silking. The nitrogen content of grain was the minimum (1.12 %) when the crop was harvested at 16 days or 20 days after silking. The nitrogen content of stover was not affected by variation in date of harvest. However, nitrogen content of stover was the maximum (0.41%) when the crop was harvested at 32 days after silking. The interaction effect of the fertility level and harvesting date on nitrogen content of grain and stover was not found significant.

4.3.2 Phosphorus

Neither variation in fertility level not different dates of harvest had any significant effect on the phosphorus content of grain and straw. However, treatment F_3 receiving highest level of fertility recorded maximum phosphorus content in the grain (0.37%). The phosphorus content was the minimum of 0.35 per cent in the grain when minimum fertilizer applied to the crop as in the case of F_1. The treatment F_3 receiving maximum quantity of fertilizer exhibited maximum phosphorus percentage (0.20%) in the stover (Table 4.14). The phosphorus content of grain was the maximum (0.38%) when harvested at 32 days after silking. Maximum concentration (0.20%) of phosphorus was recorded in stover when harvested at 32 days after silking. The phosphorus content of stover was the minimum (0.18%) from the crop harvested 16 days after silking.

Table 4.14 Effect of levels of fertility and harvest date on nutrient content (%)

Treatment	Nitrogen		Phosphorus		Potassium	
Main plot	**Grain**	**Stover**	**Grain**	**Stover**	**Grain**	**Stover**
F_1	1.06	0.34	0.35	0.19	0.49	1.15
F_2	1.18	0.40	0.36	0.19	0.51	1.16
F_3	1.20	0.43	0.37	0.20	0.52	1.16
SE(m)$\pm$	0.023	0.011	0.007	0.006	0.013	0.026
CD (0.05)	0.091	0.041	NS	NS	NS	NS
Sub plot						
H_1	1.12	0.38	0.34	0.18	0.49	1.14
H_2	1.12	0.38	0.35	0.19	0.50	1.15
H_3	1.14	0.39	0.36	0.19	0.51	1.15
H_4	1.17	0.39	0.36	0.19	0.52	1.16
H_5	1.18	0.41	0.38	0.20	0.52	1.17
SE(m)$\pm$	0.014	0.009	0.009	0.007	0.008	0.006
CD (0.05)	0.039	NS	NS	NS	NS	0.019

4.3.3 Potassium

Fertilizer application did not have any significant effect on potassium content of either grain or stover. However, potassium content of grain was the maximum (0.52%) with the crop receiving maximum fertilizer as in case of F_3. The crops in the treatment F_3 receiving highest quantity of fertilizer exhibited the highest content of potassium (1.16%) in stover, of course the value was same in case of F_2 (Table 4.14). The potassium content of grain was not significantly affected by variation in date of harvest. But, date of harvest significantly affected the potassium content of stover. The potassium content of stover was the maximum (1.17%) when the crop was harvested at 32 days after emergence of silk. But this was statistically at par with the treatment harvested at 28 days after emergence of silk. The potassium content of stover was the minimum (1.14%) when harvested at 16 days after silking. The interaction effect between fertility levels and the harvesting date on potassium content of either grain or stover was not significant.

4.4. Uptake of nutrients

4.4.1. Nitrogen

Variation in fertilizer application significantly affected the removal of nitrogen by both grain and stover. Maximum quantity of nitrogen was taken up by the grain (47.0 kg ha^{-1}) in the treatment F_3 receiving maximum quantity of fertilizer. This was significantly higher than other levels of fertilizer application. There was also maximum uptake of nitrogen by the stover when the crop was applied with 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare (Table 4.15). But it was statistically similar with the fertility level of 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. Minimum quantity of nitrogen was taken up by grain (36.4 kg ha^{-1}) and stover (29.2 kg ha^{-1}) when the crop was fertilized with 40 kg nitrogen, 20 kg phosphorus and 20 kg potash per hectare.

Removal of nitrogen uptake by the grain and the stover was also significantly affected by variation in date of harvest. The maximum quantity of nitrogen (47.7 kg ha^{-1}) was taken up by the grain in the treatments harvested at 32 days after silk emergence. However, it did not differ statistically from the treatments harvested at 18 days after silk emergence. Plots when harvested at 16 days after silk emergence, depicted lowest quantity of nitrogen (34.2 kg ha^{-1}) uptake by the grain. The removal of nitrogen by stover followed similar trend with maximum uptake (43.3 kg ha^{-1}) from the treatments harvested at 32 days after silking. This was statistically at par with the plots harvested at 24 or 28 days after silking. A minimum of 35.4 kg nitrogen per hectare was removed by the stover when the crop was harvested at 16 days after silking. There was no interaction effect of fertility level and the harvesting date on nitrogen uptake of grain or stover.

4.4.2 Phosphorus

The variation in quantity of fertilizer applied significantly affected the quantity of phosphorus removal by grain and stover. Maximum quantity of phosphorus was removed by the grain (14.5 kg ha^{-1}) and the stover (21.4 kg ha^{-1}) from the plots provided with 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare (Table 4.15). With respect to phosphorus removal by the grain, this was statistically higher than other levels of fertilizer application. In case of phosphorus removal by the stover, it was found similar with application of 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. The treatment F_1 with lowest level of fertility exhibited minimum removal of phosphorus both by grain and stover.

Table 4.15 Effect of levels of fertility and harvest date on uptake of nutrients (kg ha^{-1})

Treatment	Nitrogen		Phosphorus		Potassium	
Main plot	**Grain**	**Stover**	**Grain**	**Stover**	**Grain**	**Stover**
F_1	36.4	29.2	12.1	16.5	16.9	97.1
F_2	44.1	42.6	13.3	19.7	19.0	122.5
F_3	47.0	46.6	14.5	21.4	20.4	127.1
SE(m) ±	0.67	1.51	0.24	0.52	0.57	2.79
CD (0.05)	2.63	5.93	0.95	2.05	2.23	10.95
Sub plot						
H_1	34.2	35.4	10.5	16.9	14.9	105.7
H_2	39.1	37.4	12.1	19.0	17.4	112.2
H_3	44.6	39.9	14.0	19.4	19.9	115.8
H_4	46.7	41.4	14.5	20.2	20.6	121.1
H_5	47.7	43.3	15.2	20.8	21.1	123.1
SE(m) ±	0.92	1.29	0.42	1.01	0.46	3.12
CD (0.05)	2.70	3.78	1.22	NS	1.35	9.12

Harvesting the crop at 32 days after emergence of female flower resulted in maximum removal of phosphorus (15.2 kg ha^{-1}) by the grain (Table 4.15). Moreover such uptake value was similar with the treatments harvested at 24 or 28 days after silk emergence. There was removal of minimum quantity of 10.5 kg ha^{-1} by the grain when the crop was harvested at 16 days after silking. There was no effect of harvesting date on phosphorus uptake by stover. However, harvesting the crop at 32 days after silk emergence recorded maximum phosphorus removal of 20.8 kg ha^{-1} by the stover. There was minimum phosphorus uptake of 16.9 kg ha^{-1} by stover when the crop was harvested at 16 days after silking (Table 4.15). There was no interaction effect of fertility level and date of harvest on phosphorus uptake of grain or stover.

4.4.3 Potassium

The effect of fertility level was significant on potassium removal by the grain and the stover. Application of maximum quantity of fertilizer (F_3) resulted in maximum removal of potassium by the grain. This was statistically comparable with the treatment F_2 provided with 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. The potassium removal by the stover was the maximum of 127.1 kg ha^{-1} in the treatment F_3 receiving highest level of fertility. It was statistically at par with the plots receiving 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare. The potassium removal by grain (16.9 kg ha^{-1}) and stover (97.1 kg ha^{-1}) was the minimum with application of 40 kg nitrogen, 20 kg phosphorus and 20 kg potash per hectare (Table 4.15).

Date of harvest also significantly affected the quantity of removal of potassium by the grain and the stover. The removal of potassium by the grain was the maximum of 21.1 kg ha^{-1} from the treatments harvested at 32 days after silking. It was statistically comparable with the treatments harvested at 24 or 28 days after silk emergence. There was minimum removal of potassium (14.9 kg ha^{-1}) by the grain when the crop was harvested at 16 days after silk emergence. Similar trend was followed for potassium uptake by stover with maximum uptake of 123.1 kg ha^{-1} from the plots harvested at 32 days after silking. It was statistically at par with the plots harvested at 24 or 28 days after silking.

There was minimum removal of potassium (105.7 kg ha^{-1}) from the soil by the stover with earliest harvest of the crop at 16 days after silk emergence. The interaction effect of fertility level and harvesting date was not found significant with respect to removal of potassium by the grain or stover.

4.4.4 Total Nutrient uptake ($N+P_2O_5+K_2O$)

Fertilizer application significantly affected total removal of major nutrients viz. Nitrogen, phosphorus and potassium either individually or in combination. The maximum removal of three nutrients (277.0 kg ha^{-1}) was recorded with the treatments receiving 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare. This removal was superior over all other levels of fertilizer application (Table 4.16). Removal of maximum quantity of these nutrients individually viz. 93.6 kg nitrogen, 35.9 kg phosphorus and 147.5 kg potassium per hectare was realized with highest level of fertilizer application i.e. 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare.

Total uptake of nitrogen, phosphorus and potassium individually or in combination ($N+P_2O_5+K_2O$) were significantly affected by date of harvest. Harvesting the crop at 32 days after silking recorded maximum nutrient uptake of 271.2 kg ha^{-1}, which was at par with harvesting at 28 days after silking. Harvesting at 16 days after silking recorded the minimum nutrient uptake of 217.6 kg ha^{-1} by the crop (Table 4.16). There was no interaction effect of fertility level and date of harvest on removal of these nutrients.

Table 4.16 Effect of fertility level and harvest date on removal of nutrients (kg ha^{-1})

Treatment	Nitrogen	Phosphorus	Potassium	Total
Main plot				
F_1	65.6	28.6	114.1	208.3
F_2	86.6	33.0	141.5	261.1
F_3	93.6	35.9	147.5	277.0
SE(m) $\pm$	1.10	0.57	2.86	2.89
CD (0.05)	4.33	2.25	11.21	11.36
Sub plot				
H_1	69.6	27.4	120.6	217.6
H_2	76.5	31.1	129.6	237.2
H_3	84.5	33.4	135.7	253.6
H_4	88.1	34.7	141.7	264.5
H_5	91.0	36.0	144.2	271.2
SE(m) $\pm$	1.83	1.06	3.17	5.48
CD (0.05)	5.33	3.08	9.25	15.99

4.5 Economics

Fertility level and date of harvest significantly influenced the economics of sweet corn cultivation. The cost of cultivation was more in case of highest fertility level (F_3) because of additional expenditure incurred for higher quantity of fertilizer and its application. There was maximum gross income of Rs 1,62,117 ha^{-1}, maximum net return of Rs 1,08,732 ha^{-1} and highest benefit-cost ratio of 3.03 realized in treatment F_3 with highest level of fertility. These values have been found statistically at par with application of 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per hectare (Table 4.17). The treatment F_1 receiving 40 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1} realized minimum net profit of Rs 81,882 ha^{-1} and minimum benefit-cost ratio of 2.63. There was 32.8 per cent enhancement of net return with application of 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare as compared with the fertility level of 40 kg nitrogen, 20 kg phosphorus and 20 kg potash per hectare.

Table 4.17. Effect of fertility level and harvest date on economics (Rs)

Treatments	Cost of cultivation	Gross income	Net profit	Benefit-cost ratio
Main plot				
F_1	50370	132252	81882	2.63
F_2	52155	153193	101038	2.93
F_3	53385	162117	108732	3.03
SE(m) $\pm$	228	2429	2522	0.053
CD (0.05)	896	9537	9899	0.208
Sub plot				
H_1	51256	124292	73036	2.42
H_2	51528	135285	83757	2.63
H_3	51789	158864	107075	3.06
H_4	52350	162237	109887	3.09
H_5	52925	165257	112332	3.12
SE(m) $\pm$	344	3714	3687	0.072
CD (0.05)	1003	10841	10763	0.210

The crop harvested at 32 days after silk emergence realized maximum gross income of Rs 1,65,257 and net profit of Rs 1,12,332 per hectare. The gross return and net profit obtained with harvesting at 32 days after silking were statistically at par with the treatments harvested at 24 or 28 days after silking. Harvesting the crop at 16 days after silk emergence recorded minimum values of gross income (Rs 124292 ha^{-1}) and net profit (Rs 73036 ha^{-1}) along with benefit-cost ratio of 2.42 (Table 4.17). The interaction effect of fertility level and harvesting date on economics of sweet corn cultivation was not found significant.

DISCUSSION

Observations recorded during experimentation are elaborated in the previous chapter. In this chapter, the effects of treatments and possible causes are explained to derive the probable reasons of the findings. Based on available literature; the possible effects of the levels of fertility and harvesting date on plant growth, yield attributing factors, productivity of green cob and fodder, removal of various nutrients and economics of cultivation are depicted with possible reasons.

5.1 Crop growth and development

Maize is the most versatile crop, which can be suitably grown under different agro-climatic situations (Singh *et al*., 2005). Variation in local weather parameters directly affects the growth and development of this crop. The growth process of maize is restricted when exposed to extreme temperature events for a prolonged period. A prolonged exposure to temperature below 10 ^{0}C decreases leaf expansion (Miedema, 1982). The average of the minimum weekly temperature varied in between 13.2 to 19.1 degree Celsius. This is above the minimum temperature requirement for growth of maize crop. Zaidi and Singh (2005) opined that optimum temperature range between 30-35^{0}C is suitable for shoot, root and leaf development. The average of maximum weekly temperature was in the range from 24.3 ^{o}C to 30.4 ^{o}C, which was close to the required temperature for growth and development of the crop.

The genetic potential of a variety and the environmental factors are mostly responsible for growth and development of any plant. Development of shoot is the cumulative effect of growth of leaf with regards to its number & size, node and internode. Increase in plant height is the effect of shoot growth, which was influenced by the levels of fertility. Enhanced level of fertilizer application to the level of 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare produced tallest plants at all stages of crop growth due to accelerated process of cell division and other physiological activities. The findings are in conformity with the results obtained by Rao *et al*. (2020) and Jat *et al*. (2009). The rate of growth of plant height attained its maximum during 45-60 days after sowing that coincides with tassel emergence (Fig. 4.1).

Leaf area index (LAI) is crucial for efficient utilization of solar radiation that contributes to dry matter accumulation through increased photosynthetic activity. The leaf area index increased constantly with duration of the crop till harvest; but the rate of increase was comparatively higher up to 60 days after sowing (Fig. 4.2). Commencement of reproductive stage with tassel emergence restricted initiation of new leaf, which brought a plateau in enhancement of leaf area index. Timely release of adequate quantity of plant nutrients as in case of the maximum level of fertilizer application resulted in the highest value of leaf area index at all the stages of plant growth. This finding is in agreement with the results obtained by Rao *et al*. (2020).

Increase in LAI due to application of higher dose of fertilizer increased the photosynthetic activity thereby enhancing accumulation of dry matter at various growth stages of the crop. The highest level of fertilizer application resulted in the maximum quantity of dry matter production of 853.0 g m^{-2} at harvest due to maximum plant height (183.7 cm) and highest leaf area index (4.24). Adequate supply of plant nutrients might have accelerated cell division, which had resulted in higher dry matter production. Similar findings have been reported by Singh *et al*. (2019), who obtained maximum dry matter production with application of N, P_2O_5 and K_2O @ 120, 60 and 40 kg ha^{-1}. Deficient supply of plant nutrients due to application of lowest level of fertilizer was the cause for low quantity of dry matter accumulation at different stages of crop growth (Fig. 4.3).

Rapid growth of various plant parts due to higher level of plant nutrients resulted in higher crop growth rate with highest level of fertility. The crop growth rate was significantly influenced by variation in fertility level up to 45 days after sowing because of availability of plant nutrients in adequate quantity, which was received from basal application of highest level of fertility. It is in confirmation with the opinion expressed by Akpan and Udoh (2017), who endorsed that increase in quantity of applied fertilizer resulted better growth of sweet corn. Availability of adequate quantity of plant nutrients in case of highest fertility level accelerated the process of plant growth, which was reflected in earliness of tasseling and silking.

5.2 Yield and yield attributes

Promotion of physiological activities with availability of adequate quantity of plant nutrients hastens various yield attributing factors of sweet corn. Maximum number of heaviest cobs were harvested with application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}, being statistically comparable with the fertility level of 80:40:40 kg N: P_2O_5:K_2O ha^{-1}. Inadequate availability of various plant nutrients in case of minimum level of fertilizer application was the main cause for reduction of yield attributes like cob number (71.47 thousand ha^{-1}), cob weight with husk (314.8 g) and hundred kernel weight (30.3 g) with application of 40:20:20 kg N:P_2O_5:K_2O ha^{-1}. Development of reproductive structure such as number of ovules is affected by deficient supply of plant nutrients at reproductive stage. Inadequate supply of plant nutrients at flowering stage with lowest level of fertilizer application negatively affected the number and weight of kernel, which resulted in low yield of green cob and kernel. Deficiency in plant nutrients at reproductive stage might be the cause for reduction in kernel and ear production. Similarly, nutrient deficiency at later stage might have resulted in leaf senescence due to diminution of photosynthesis, which was reflected in production of green cob and fodder. Application of highest level of fertilizer produced maximum number (76.91 thousand ha^{-1}) of longest (29.9 cm), thickest (16.5 cm) and heaviest green cob with husk (349.9 g). Shanti *et al.* (2012) from Hyderabad also reported similar findings.

Adequate supply of plant nutrients at all the crop growth stages in case highest level of fertilizer application resulted in the highest production of green cob (15.63 t ha^{-1}) and fresh kernel (7.86 t ha^{-1}). Dangariya *et al.* (2017) also obtained maximum yield of green cob (8.10 t ha^{-1}) with per hectare application of 120 kg nitrogen and 60 kg phosphorus. Yield of green cob and fresh kernel are directly influenced by various yield attributing characters. Increase in length of cob due to enhanced quantity of nutrient availability for a longer period under the highest level of fertility resulted in production of heaviest kernels and thereby increased in kernel yield. Supply of plant nutrients in higher quantity during crop growth stages created a favourable environment for better growth and yield of crop. This has produced 23.5 per cent more green cob, 28.9 per cent more fodder and 14.9 per cent more kernel yield with fertility level of 120:60:60 kg N:P_2O_5:K_2O ha^{-1} than application of 40:20:20 kg N:P_2O_5:K_2O ha^{-1} (Table 4.10).

Precision in time of harvest is very much important to ensure better yield of good quality sweet corn (Ruan *et al.*, 1999). In case of delayed harvest, the crop gets more time for photosynthesis and thereby more accumulation of assimilate. The length and girth of the cob increased progressively with progress in harvesting date, but the growth was not significant after 24 days of silking (Table 4.8). The number and weight of kernel attained their optimum values when the crop was harvested at 24 days after silking. All these factors contributed to obtain optimum yield of green cob (15.22 t ha^{-1}) and fresh kernel (7.82 t ha^{-1}) in the treatments harvested at 24 days after silking. Although there was marginal enhancement of yield by harvesting beyond this date, the increase was not significant due to senescence of lower leaves. Under Thailand situation, Sumitra *et al.* (1992) recommended 16-22 days after 50 % silking stage as the appropriate time for harvest of sweet corn. Optimum quantity of green cob was obtained from the plots applied with 120:60:60 kg $N:P_2O_5:K_2O$ ha^{-1} and harvesting at 24 days after silking.

Highest fertility level contributed remarkably to obtain tallest plants and maximum dry matter accumulation, which was reflected in maximum yield of 36.42 t ha^{-1} green fodder due to adequate supply of plant nutrients. The photosynthetic activity was continuously maintained throughout the cropping season through availability of plant nutrients at higher level in balanced quantity, which has resulted in production of maximum quantity of green with the highest fertility level (Table 4.10). This is in agreement with the findings reported by Mathukia *et al.* (2014) and Rathod *et al.* (2018). Although fodder yield was increased up to 32 days after silking, the rate of growth was decelerated after 24 days of silking due to reduction in photosynthetically active leaves at the later stage of reproductive phase.

5.3 Quality of sweet corn

The quality parameters of sweet corn are mainly influenced by total soluble sugar content of kernel. The quantity of total soluble sugar present in the kernel is largely dependent on the harvesting date. There is less sugar content in the kernel at the early part of grain formation, which was evidenced from the lowest sugar content (7.7 %) of the kernel harvested at 16 days after silking. Subsequently, total soluble sugar content of kernel increased to attain its maximum value of 12.9 per cent at 24 days after silking and then after it started waning due to conversion of sugar into starch. Hence, the sugar content of kernel traversed in a parabolic path from 16 to 32 days after silking with its peak at 24 days after silking. Mehta *et al.* (2017) also advocated harvesting at 24 days after pollination to obtain maximum brix percentage of super sweet corn. Of course, Khanduri *et al*. (2011) recorded maximum sugar concentration of kernel at 20 days after pollination. The soluble sugar content of kernel was the maximum (10.87 %) with the lowest level of fertilizer application due to diminution in nitrogen supply at reproductive stage of the crop.

As nitrogen is the integral part of protein synthesis, increase in fertility level increased the protein content of kernel due to adequate supply of nitrogen at the reproductive stage. This is in conformity with the findings by Sunitha and Reddy (2012), who recorded the highest protein content in kernel with highest level of fertilizer application. Protein content of the kernel increased constantly with progress of date of harvest attaining its maximum value of 7.35 per cent at 32 days after silking, although the optimum value was obtained at 28 days after silking.

5.4 Nutrient uptake

The highest level of fertility enabled the crop to get adequate quantity of plant nutrients from the soil, which ultimately created conducive condition for extensive root growth to absorb higher quantity of plant nutrients from an extended volume of soil. The quantity of nutrient uptake by plant is reflected in the yield and nutrient content of the produce. Removal of major nutrients such as nitrogen, phosphorus and potassium was at their peak in the treatments receiving the highest level of fertility, obviously due to non-deficient supply of these nutrients during crop growth stages. There was enhancement in uptake of all the three nutrients in combination by 33 per cent with highest fertility level as compared with lowest level of fertility. There was higher quantity of nutrient removal in case of highest level of fertilizer application due to maximum yield coupled with higher nutrient content of grain and stover. Sunitha and Reddy (2012) also reported remarkable increase in removal of nitrogen, phosphorus and potassium with successive enhancement in quantity of applied nutrients. Meena *et al.* (2007) also observed maximum uptake of NPK with application of 120 kg N ha^{-1} under Gujarat situation in rabi season.

The uptake of NPK significantly increased with progress of the harvest date up to 28 days after silking, may be due to longer duration for absorption of the nutrients by the plant. The uptake of plant nutrients by kernel and stover were positively affected by duration of the crop. Maximum uptake of nutrients was observed with harvest at 32 days after silking although it was statistically similar with harvest at 28 days after silking. The senescence of lower leaves and slow down of photosynthetic activity at the tail end of crop growth might have arrested the process of nutrient uptake by the crop.

5.5 Economics

Yield of green cob and fodder considerably influences the profit obtained from sweet corn cultivation. Application of the highest level of fertilizer resulted in maximum net profit and highest benefit-cost ratio because of higher yield from green cob and green fodder. Kumar and Chawla (2018) and Singh *et al*. (2019) also recorded increased net profit with increased level of fertilizer application in sweet corn.

There was increase in net profit and benefit-cost ratio with progress in date of harvest up to 24 days after silking. The net profit (Rs 1.07 lakh ha^{-1}) was optimally high when the crop was harvested at 24 days after silking due to optimum yield of sweet corn and fodder. There was 46.6 per cent increase in net profit with harvesting at 24 days after silking as compared with the crop harvested at 16 days after silk emergence because of more yield obtained from green cob and green fodder.

Higher soluble sugar content of kernel from the crop, harvested at 24 days after silking might have increased the market price that could nullify the additional benefit of higher yield by harvesting beyond this date. Additionally, early harvest would make the land free for growing the subsequent crops. Hence, it is prudent to harvest sweet corn crop at 24 days after silking.

SUMMARY AND CONCLUSION

Sweet corn cultivation is gaining popularity among the farming community due to its sweetness and increasing market demand. Development of location specific technology can enable the farmers to grow sweet corn under diversified agro-climatic situations. Among various agronomic management practices, nutrient management and time of harvest play a vital role in deciding the yield and quality of sweet corn. The crop can be better managed for obtaining optimum yield and higher profit with precise adoption of such technology. There is paucity of research information on effect of date of harvest regarding quality and productivity of sweet corn. With this backdrop, a field experiment was conducted to determine the effect of fertility level and harvesting date on plant growth and yield of sweet corn. Research findings, recorded in the course of experimentation, are summarized below to infer the conclusion.

1. The plant height increased rapidly during 45 and 60 days after sowing due to emergence of tassel in the reproductive phase.

2. Leaf area index increased at a faster rate till 60 days after sowing and subsequently, the rate of growth was at a plateau.

3. Increase in fertility level up to the highest level of fertility i.e. 120 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare increased the leaf area index.

4. Maximum dry matter (853.0 g m^{-2}) was accumulated at harvest stage with the highest level of fertilizer application.

5. The growth rate of the crop increased in an accelerated manner till 60 days after sowing and then after the growth was slowed down.

6. Application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} induced earliness in emergence of tassel and silk as compared with other levels of fertility.

7. Longest (29.9 cm) cob with maximum girth (16.5 cm) was produced in the treatments receiving the highest level of fertilizer.

8. Harvesting after 32 days of silking resulted in maximum length (30.8 cm) and girth (19.1 cm) of the cob.

9. The weight of green cob with husk was maximum (349.9 g) in the treatment receiving maximum quantity of fertilizer.

10. Weight cob with husk increased significantly up to harvesting at 24 days after silking (360.8 g).

11. Fresh kernel weight (32.7 g hundred^{-1}) was maximum with application of 120:60:60 kg $N:P_2O_5:K_2O$ ha^{-1}, which was statistically at par with the fertility level of 80:40:40 kg $N:P_2O_5:K_2O$ ha^{-1}.

12. There was no significant difference in kernel count per cob, when the crop was harvested at 24, 28 or 32 days after silking.

13. Weight of fresh kernel attained the maximum value (33.8 g hundred^{-1}) when harvested at 32 days after silk emergence, but it was statistically comparable with the treatments harvested at 24 and 28 days after silk emergence.

14. Maximum yield of green cob (15.63 t ha^{-1}) was realized with application of 120:60:60 kg $N:P_2O_5:K_2O$ ha^{-1}.

15. The green cob yield of 15.22 t ha^{-1} was optimum in the treatments harvested at 24 days after silk emergence.

16. A maximum of 36.42 t ha^{-1} fodder yield was realized with application of 120:60:60 kg $N:P_2O_5:K_2O$ ha^{-1}.

17. Application of 120:60:60 kg $N:P_2O_5:K_2O$ ha^{-1} resulted in maximum yield of fresh kernel (7.86 t ha^{-1}).

18. Yield of fresh kernel increased significantly with date of harvest up to 24 days after silking (7.82 t ha^{-1}).

19. Harvesting the crop at 24 days after silking resulted in the maximum (12.9%) total soluble sugar content of kernel.

20. Application of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} resulted in maximum content of nitrogen in grain (1.20 %) and stover (0.43 %).

21. The maximum removal of 93.6 kg N, 35.9 kg P and 147.5 kg K per hectare by the crop provided with 120:60:60 kg N:P_2O_5:K_2O ha^{-1}.

22. Crops harvested at 32 days after silk emergence removed 91.0 kg N, 36.0 kg P and 144.2 kg K per hectare, which was higher that other dates of harvest.

23. Crops receiving highest level of fertilizer i.e. 120:60:60 kg N:P_2O_5:K_2O ha^{-1} realized the highest net return of Rs 1,08,732 per hectare and maximum benefit-cost ratio of 3.03.

24. Optimum net profit of Rs 1,07,075 per hectare was obtained by harvesting the crop at 24 days after silk emergence, which was statistically comparable with the treatments harvested at 28 and 32 days after silk emergence.

CONCLUSION

Fertilizer application at 120:60:60 kg N:P_2O_5:K_2O ha^{-1} with harvesting at 24 days after silking may be advocated for obtaining optimum yield of green cob and fodder with optimum net profit. This will ensure harvesting good quality sweet corn with maximum sugar content in the kernel to fetch good market price. Further, harvesting the crop at 24 days after silking will enable to take the subsequent crop in the same field without sacrificing the yield or profit.

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CERTIFICATE OF ANTI-PLAGIARISM

(For P.G.Thesis)

This is to certify that the thesis entitled **"Yield and quality of sweet corn** ***(Zea mays var. saccharata)*** **under different fertility levels and time of harvest"** submitted by **Nityashree Pradhan** bearing Admission No. **18122E22**, **Department of Agronomy, College of Agriculture, OUAT, Bhubaneswar** has been checked for Anti-plagiarism by using TURNITIN WebPortal and similarity index was found within 15% level (From Abstract to Summary and Conclusion) as prescribed by Anti-Plagiarism policy of OUAT.

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