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Effect of Integrated Nutrient Management on Quality, Nutrient Content and Uptake of Sweet Corn (*Zea mays* var. saccharata)

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Authors' contributions

This work was carried out in collaboration between all authors. Author SR designed the study, wrote the protocol and wrote the first draft of the manuscript. Author RHK reviewed the experimental design and all drafts of the manuscript. Authors SR and RHK managed the analyses of the study. Authors SH and MHK performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

A field study was carried out at Experimental Farm of Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, J&K, India during *kharif* 2013 and 2014 to study the influence of integrated nutrient management on quality, nutrient content and uptake of sweet corn. The experiment comprising of 12 treatments including organic and inorganic fertilizers was laid in a Randomized Complete Block Design with three replications. Sweet corn variety Super-75 was used as an experimental material. The results revealed that the quality parameters viz, sugar, starch, protein and vitamin C content were significantly highest in treatment 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB), whereas unfertilized control recorded significantly lowest values of these parameters. Nitrogen, phosphorus and potassium content and uptake showed significant and consistent improvement with application of 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB), however,

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significantly lowest nitrogen, phosphorus and potassium content and uptake were obtained under unfertilized control during experimentation years. Hence, it is concluded that application of 75 % (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) is significantly superior in terms of quality parameters viz., sugar, starch, vitamin C, protein content and NPK content and uptake as against unfertilized control and various other treatments.

Keywords: Integrated nutrient management; nutrient content and uptake; protein; starch; sugar; sweet corn; vitamin C.

1. INTRODUCTION

Sweet corn (*Zea mays* var. *saccharata*) also called sugar corn and pole corn is a variety of maize with high sugar content. Sweet corn is one of the most popular vegetables in the USA, Canada and Australia. It is becoming popular in India and other Asian countries. Sweet corn differs from other corns (field maize, pop corn and ornamental) because the kernels have a high sugar content in the milk on early dough stage. It is consumed in the immature stage of the crop. The kernels of sweet corn taste much sweeter than normal corn, especially at 25-30% maturity. The quality and level of sweet corn depends on the type of gene involved for sweetness. The sweet corn is relatively high in oil content which is predominantly rich in linolenic (50%) and oleic (30%) acids. It also contains good amount of calcium (Ca), phosphorus (P), iron (Fe) and potassium (K). Protein content ranges from 2.86 to 3.70%. It contains a higher proportion of sitosterol (47%). Due to high oil content, flavours and colours develop in processed sweet corn. Sweet corn contains thiamine, riboflavin, niacin, vitamin B6 and Vitamin 'A' as major vitamins. Lipoxygenase and Peroxidase enzymes are directly associated with off-flavor and other quality deteriorations. In Sweet corn, aroma develops due to dimethyl sulphide (DMS) and hydrogen sulphide (H_2S). It has about 9.8 per cent sugar in bicolor varieties and 11.5 per cent in yellow varieties [1]. Yellow corn has higher vitamin 'A' content than white corn.

Sweet maize like other maize types is a relatively short duration crop and can successfully be cultivated twice a year as early (spring) and late (autumn) crop. In India especially in Jammu & Kashmir, the potential of the sweet maize crop is not being exploited satisfactorily due to many constraints among which inappropriate nutrient supply ranks first. Others are pest problems, low fertility status of the soils and the high cost of the scarce inorganic fertilizers with their potential polluting effects on the environment following continuous usage. Soils of the agro-ecology are generally low in organic matter as a result of the rapid mineralization and the fact that very little organic matter is added to the soil during and after cropping [2]. The need to use renewable forms of energy has rekindled interest in the use of organic fertilizers as alternatives for inorganic fertilizer worldwide. Application of organic fertilizers plays a direct role in plant growth as a source of all the necessary major and minor nutrients in available forms during mineralization which improves both the physical and biological properties of the soil [3]. Nutrients contained in organic fertilizers are released more slowly and are stored for longer periods in the soil, thereby ensuring a long residual effect [4]. To meet crop's nutrient needs, organic fertilizers are however, required in rather large quantities which now make for a strong advocacy for fortifying these manures with inorganic fertilizers. The vermicompost @ 4.5 t ha^{-1} produced significantly more yield and sugar content which was at par with FYM @ 5 t ha^{-1}, further it was also significantly superior in respect of sugar content [5].On clay loam soils at Udaipur (Rajasthan), application of 75 per cent NPK + 2.25 t ha^{-1} vermicompost + bio fertilizers gave highest sugar content, starch content, number of cobs $plant^{-1}$, cob length and protein content of baby corn which was followed by application of 62.5 per cent NPK + 1.875 t vermicompost ha^{-1} + bio fertilizer, 50 per cent NPK + 1.50 t vermicompost ha^{-1} + bio fertilizer and 62.5 per cent NPK + 1.75 t vermicompost ha^{-1} + bio fertilizer treatments [6]. Singh et al. [7] reported significant increase in protein content and cob yield of quality protein maize with application of 100 % RDF along with 10 t ha^{-1} FYM over control. Integrated application of 50 per cent RDF + PSB 5 kg ha^{-1} + FYM 5 t + *Azotobacter* 5 kg ha^{-1} recorded the highest P content in soil after crop harvest in comparison to other treatments [8]. Maximum uptake of N, P and K by maize crop to the extent of 241.1,35.2 and 234.2 kg ha^{-1}, respectively was observed with application of sunhemp green manure + poultry manure + 100% RDN over control [9]. Further, highest uptake of N, P and K by maize crop with application of 90 kg N through urea +

30 kg N through PM ha^{-1} as against 52.5 kg N, 33.5 kg P and 11.5 kg ha^{-1} K uptake in control [10]. Keeping the above facts in view the present investigation was carried out to find out the effect of integrated nutrient management on quality, nutrient content and uptake of sweet corn.

2. MATERIALS AND METHODS

A field experiment was conducted for two consecutive years (2013 and 2014) at the Experimental Farm of the Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir. The experimental site is in mid to high altitude temperate zone characterized by hot summers and very cold winters. The mean maximum temperature recorded during the study period were 25.11℃ and 26.01℃ and mean minimum temperature was 12.24℃ and 12.21℃ during the cropping seasons of 2013 and 2014, respectively. Maximum relative humidity were 82.34 and 83.00 per cent for the years 2013 and 2014, respectively, whereas total precipitation (rainfall) amounted to 1.29 and 1.98 mm during the cropping seasons of 2013 and 2014, respectively.

The experiment comprising of 12 treatments viz., T_1 = Control , T_2 = Recommended NPK kg ha^{-1} (90:60:40), T_3 = Farm yard manure (FYM) (18 t ha^{-1}), T_4 = Vermicompost (3.6 t ha^{-1}), T_5 = Biofertilizer (*Azotobacter* + Phosphate solubilizing bacteria (PSB), T_6 = 75% (NPK) + FYM (4.5 t ha^{-1}), T_7 = 75% (NPK) + Vermicompost (0.9 t ha^{-1}), T_8 = 75% (NPK) + Biofertilizer , T_9 = 75% (NPK) + FYM (2.25 t ha^{-1}) + Vermicompost (0.45 t ha^{-1}), T_{10} = 75 % (NPK) + FYM (4.5 t/ha) + Biofertilizer (*Azotobacter* + PSB), T_{11} = 75% (NPK) + Vermicompost (0.9 t/ha) + Biofertilizer (*Azotobacter* + PSB) and T_{12} = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha) + Biofertilizer (*Azotobacter* + PSB)] was laid in a Randomized Complete Block Design with three replications. Sweet corn variety Super-75 was used as an experimental material. The experimental material was collected from the germplasm bank of Division of Agronomy, SKUAST-Kashmir.

The soil of experimental field was silty clay loam in texture, neutral in reaction and medium in available nitrogen, phosphorus and potassium. The details of the soil analysis is given (Table 1).

The chemical fertilizers Urea, DAP and MOP were used as source of nitrogen, phosphorus and potassium, respectively. Full dose of phosphorus and potassium and half dose of nitrogen were applied as basal at the time of sowing and the remaining half of nitrogen in two splits each at knee high and tassel emergence stage in the respective plots at the rates as per layout plan. Farmyard manure (FYM) and vermicompost were used as source of nitrogen, phosphorus, potassium and micro-elements in the form of organic manure and were applied to the respective plots as per the layout plan. The microbial culture of *Azotobacter* and Phosphorus solbulizing bacteria (PSB) were used as bio-fertilizers as a seed treatment (50 g kg^{-1} seed) to the respective plots. The field was irrigated twice from sowing upto the harvest of cobs.

Table 1. Physico-chemical properties of soil of experimental field

Particulars	Rating	Methods employed
Soil texture	Silty clay loam	International pipette method [11]
Available nitrogen	Medium	Alkaline potassium permanganate method [12]
Available phosphorus	Medium	Olsen's method of extraction with 0.5 N, $NaHCO_3$ [13]. Using Systronics Spectro-photometer
Available potassium	Medium	[14]

The data was recorded on the following quality parameters.

2.1 Quality Analysis

2.1.1 Sugars

Weighed fresh callus tissue mass 100 mg was extracted with 2 ml of 80% ethanol and after boiling for 2 times, the supernatant was decanted into a beaker. Extraction was repeated four times with 2 ml of 80% ethanol each time and supernatants were collected into the same beaker. Volume of the extract was made to 10 ml with 80% ethanol to 1 ml of the extract 4 ml of 0.2% anthrone reagent (200 mg anthrone in 100 ml conc. H_2SO_4) was added and the test tubes were placed in ice-cold water. The intensity of colour was read at 620 nm on Hitachi U-2000 spectrophotometer according to the method proposed by [15]. A standard curve was prepared using glucose (100 µ g ml^{-1}).

2.1.2 Starch content in grains

Weighed fresh callus tissue mass (0.5 g) and homogenized in hot 80 per cent ethanol, centrifuged (8000 rpm, 10 minutes). The residue was retained, washed repeatedly with hot 80 per cent ethanol till the washings do not give colour with anthrone reagent. The residue is dried over a water bath (100℃). 5 ml of water and 6.5 ml of 52 per cent Perchloric acid was added to the residue. This was extracted for 20 minutes at 0-4℃, centrifuged (8000 rpm, 10 minutes). The supernatant was saved, 0.2 ml of this supernatant was taken for assay to which 0.8 ml water was added followed by 4 ml of anthrone reagent. The tubes were kept in boiling water bath for 8 mts., cooled to room temperature and the intensity of green to dark green colour was read at 620 nm spectrophotometer according to the method proposed by [15]. A standard curve was prepared using glucose (100 µg ml^{-1}).

2.1.3 Vitamin C content (%)

Vitamin C was estimated by iodine titration method and pectin by 2, 6 dichlorophenol dye titration method as described by [16].

2.1.4 Protein content in grains

Protein content in grain of sweet corn was calculated by multiplying the nitrogen content of grain with a factor 6.25 as proposed by [17]. It was expressed in terms of per cent.

Further for estimation of NPK content and uptake, plant samples collected at different growth stages viz., knee high, tasseling, silking and at harvest for grain and stover from each plot were sun dried for 24-48 hours in the field and then oven dried at 60 – 65℃ for 48 hours to a constant weight. The dry weight was recorded in grams and then converted into q ha^{-1}. The samples were ground and subsequently used for chemical analyses. Nitrogen content of the ground plant samples of maize collected at different growth stages and at harvest was estimated by modified Kjeldahl's method [18]. Similarly, phosphorus content of plant samples collected at different growth stages and at harvest was determined by Vanado-molybdate phosphoric acid yellow colour method [18]. Potassium content of the ground plant samples collected at different growth stages and at harvest was estimated with the help of Flame Photometer from the digested extract prepared for phosphorus. Nitrogen, phosphorus and potassium uptake was calculated by multiplying the dry matter (oven dry) accumulated at various growth stages and at maturity in grain and stover by respective concentrations of nitrogen, phosphorus and potassium.

2.2 Plant Analysis

Plant samples collected at different growth stages viz., knee high, tasseling, silking and at harvest for grain and stover from each plot were sun dried for 24-48 hours in the field and then oven dried at 60 – 65℃ for 48 hours to a constant weight. The dry weight was recorded in grams and then converted into q ha^{-1}. The samples were ground and subsequently used for chemical analyses. The methods followed for the chemical analyses are as under.

2.2.1 Nitrogen content

Nitrogen content of the ground plant samples of maize collected at different growth stages and at harvest was estimated by modified Kjeldahl's method [18].

2.2.2 Phosphorus content

After triple acid digestion of ground plant samples, phosphorus content of plant samples collected at different growth stages and at harvest was determined by Vanado-molybdate phosphoric acid yellow colour method [18].

2.2.3 Potassium content

Potassium content of the ground plant samples collected at different growth stages and at harvest was estimated with the help of Flame Photometer from the digested extract prepared for phosphorus.

2.2.4 Nitrogen, phosphorus and potassium uptake

Nitrogen, phosphorus and potassium uptake was calculated by multiplying the dry matter (oven dry) accumulated at various growth stages and at maturity in grain and stover by respective concentrations of nitrogen, phosphorus and potassium.

2.3 Statistical Analysis

The data obtained in respect of various observations were statistically analyzed by the method described by Cochran and Cox [19]. The significance of “F” and “t” was tested at 5% level of significance. The critical difference was determined when “F” test was significant. All analyses were performed using the Statistical Package for Social Science (SPSS for windows version 16.0, SPSS Inc, Chicago, IL).

3. RESULTS AND DISCUSSION

3.1 Quality Parameters

The sugar content of sweet corn differed significantly under different treatments (Table 2). The highest sugar content was recorded in 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB) while unfertilized control showed lowest sugar content. Low sugar content in unfertilized control might be due to the non-availability of nutrients especially P. For conversion of glucose-6-phosphate and fructose-6-phosphate to sucrose-6-phosphate, phosphorus is required. Phosphorus is also required for activation of enzyme, sucrose-6-phosphatase [20]. Thus, application of 75% NPK and FYM along with biofertilizer increased the sugar content of sweet corn. These results are in accordance with the findings of [21]. The results of the present investigation indicated that application of 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB) significantly increased starch content of sweet corn which might be the function of greater conversion of CO_2 to organic compounds and CO_2 fixation, subsequently greater CO_2 assimilation. The results obtained are in close agreement with the findings of [21,22].

The per cent protein content varied widely among the treatments (Table 2). It was lowest with 8.80 per cent in unfertilized control which increased significantly 9.25 per cent in 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB). This might be due to increased availability of nitrogen and its uptake and storage in grain. Increased N content in grain could also be attributed to fixation of nitrogen through biological nitrogen fixation by *Azotobacter* culture. Nitrogen, being the principle constituent of protein might have substantially increased the protein content of kernel due to increased uptake of nitrogen under higher nutrient level when integrated with FYM and biofertilizer. Thus, better physiological and biochemical activity of sweet corn under adequate and balanced nutrient supply might have enhanced the protein content of kernel as was also confirmed by [23-25]. In the present investigation, it was observed that quality parameter like vitamin C content substantially increased with application of 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB) (Table 2). This might be due to improvement in organic matter content of the soil by decomposition of organic material. The elevated amount in vitamin C content may also be attributed to the beneficial effects of FYM and biofertilizer with NPK represented in increasing liberate of more nutrients from the unavailable reserves as correcting iron and zinc deficiency which returned in efficiency of photosynthesis process, increasing amino acids and vitamins to be absorbed by plant roots. Hence, this play an important role in plant metabolism, notably the most significant function would appear to involve in carbohydrate metabolism [26]. In addition, FYM components of available macro and micro nutrients and their role in increasing root surface per unit of soil volume as well as the high capacity of the plants building metabolites, which in turn contribute much to increase of nutrients uptake.

3.2 Nutrient Content and Uptake

3.2.1 Nitrogen content and uptake

The data on nitrogen content in sweet corn during 2013 and 2014 as affected by different treatments is presented in Table 3. From the perusal of the data it is evident that application of 75% (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) significantly increased the nitrogen content compared to rest of the treatments. Significantly lowest nitrogen content was obtained under unfertilized control during experimentation years. Similarly, nitrogen uptake indicated wide variation amongst treatments with regard to nitrogen uptake by sweet corn at harvest. The results infer that treatment 75 % (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) recorded N uptake of 217.83, 226.04 and 221.92 kg ha^{-1}, respectively during 2013, 2014 and pooled data over years, respectively, which was significantly higher than all other treatments. Significantly lowest nitrogen uptake of 82.82, 79.48 and 81.14 kg ha^{-1} during 2013, 2014 and pooled data over years, respectively, was recorded by unfertilized control.

3.2.2 Phosphorus content and uptake

Table 4 records the data pertaining to phosphorus content in sweet corn at harvest as influenced by different treatments. The data indicated that application of 75% (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) recorded phosphorus contents of 0.25, 0.26 and 0.26 per cent during 2013, 2014 and pooled data over years, respectively, which was significantly higher than rest of the treatments. Significantly lowest phosphorus content was noticed in unfertilized control. Simialrly, phosphorus uptake also showed wide variation amongst the treatments with regard to phosphorus uptake by sweet corn during the period of experimentation. From the perusal of the data it is evident that application of 75% (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) recorded phosphorus uptake of 47.36, 50.13 and 48.78 kg ha^{-1} during 2013, 2014 and pooled data over years, respectively, which was statistically higher than all other treatments tested. Significantly lowest phosphorus uptake was observed with unfertilized treatment during period of investigation.

3.2.3 Potassium content and uptake

The potassium content in sweet corn at harvest varied markedly due to influence of various treatments during both years of experimentation (Table 5). The data revealed that application of 75% (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) recorded potassium contents of 1.17, 1.18 and 1.18 per cent during 2013, 2014 and pooled data over years, respectively, which was significantly higher than rest of the treatments tested. Significantly lowest potassium contents of 0.98, 0.97 and 0.98 per cent during 2013, 2014 and pooled data over years, respectively, were noticed under unfertilized treatment. Further, the Table revealed that the treatment 75% (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) recorded the potassium uptake of 221.62, 227.98 and 224.79 kg ha^{-1} during 2013, 2014 and pooled data over years, respectively, which was significantly higher than remaining treatments. The next higher treatment recording potassium uptake was 75 % (NPK) + FYM (2.25 t ha^{-1}) + vermicompost (0.45 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB) which being at par with 75% (NPK) + FYM (2.25 t ha^{-1}) + vermicompost (0.45 t ha^{-1}) and 75% (NPK) + vermicompost (0.9 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB) was significantly superior to other treatments. The unfertilized control recorded statistically lowest potassium uptake during the two years on investigation as well as pooled data over years.

The improvement in NPK content of plant tissue under 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB) seems to be on account of their availability in soil environment and enhanced translocation in plant system. Moreover, increase in shoot growth was noticed as evident from higher drymatter accumulation. Further, it is a known fact that FYM, apart from increasing availability of nitrogen, produces humic substances which release phosphorus from iron and aluminium oxides thereby increasing availability of phosphorus to plants. Likewise phosphorus, potassium content also increased with application of 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB). The positive and significant effect of organic manure on K-uptake is attributed to better supply of these nutrients from organic sources and to the proliferous root soil sources besides improvement in physical conditions. [26-29] have also reported similar findings.

In general, total uptake of a nutrient by plant depends along with other factors on dry matter production and nutrient concentration as the uptake is mathematically equal to the product of dry matter production and its respective nutrient concentration. Studies on nutrient uptake in sweet corn showed that application of 75% (NPK) + FYM (4.5 t ha^{-1}) + biofertilizer (*Azotobacter* + PSB) significantly increased the NPK uptake. Increased availability of nutrients particularly phosphorus following fertilizer application due to quick release can be reasoned for improved nutritional environment both in the rootzone as well as in plant system. This might have helped in better root development which are responsible for NPK absorption. The increase in P uptake could also be attributed to synergistic effect of nitrogen in FYM with phosphorus. When water soluble phosphorus compounds and nitrogen are applied together, plant roots proliferate extensively in that area of treated soil resulting in more uptake of the nutrient. The present findings are in close agreement with the results obtained by [28,30-33] reported that application of RDF along with FYM and biofertilizer (*Azotobacter*, PSB and VAM) produced higher NPK uptake by wheat over RDF alone and control.

Table 2. Effect of integrated nutrient management on quality parameters of sweet corn

Treatments	Sugar content (%)			Starch content (%)			Protein content (%)			Vitamin C content (%)		
	2013	**2014**	**Mean**	**2013**	**2014**	**Mean**	**2013**	**2014**	**Mean**	**2013**	**2014**	**Mean**
T1	23.59	23.57	23.58	12.32	12.30	12.31	8.81	8.78	8.80	8.94	8.85	8.90
T2	25.02	25.07	25.05	12.66	12.67	12.67	9.14	9.16	9.15	9.45	9.56	9.51
T3	24.69	24.75	24.72	12.55	12.63	12.59	9.00	9.12	9.06	9.22	9.28	9.25
T4	24.72	24.77	24.75	12.59	12.62	12.61	9.05	9.08	9.07	9.29	9.35	9.32
T5	24.74	24.78	24.76	12.65	12.65	12.65	9.10	9.12	9.11	9.31	9.38	9.35
T6	24.76	24.85	24.81	12.59	12.66	12.63	9.13	9.16	9.15	9.37	9.45	9.41
T7	24.82	24.87	24.85	12.66	12.67	12.67	9.15	9.17	9.16	9.38	9.49	9.44
T8	24.90	24.95	24.93	12.68	12.70	12.69	9.19	9.23	9.21	9.56	9.64	9.60
T9	24.94	24.99	24.97	12.69	12.72	12.71	9.20	9.23	9.22	9.58	9.68	9.63
T10	25.08	25.13	25.11	12.73	12.77	12.75	9.24	9.26	9.25	9.78	9.85	9.82
T11	25.02	25.03	25.03	12.68	12.70	12.69	9.18	9.23	9.21	9.67	9.74	9.71
T12	25.04	25.07	25.06	12.70	12.72	12.71	9.21	9.24	9.23	9.72	9.81	9.77
SEm±	0.060	0.063	0.062	0.017	0.019	0.019	0.020	0.022	0.021	0.031	0.031	0.031
CD (p=0.05)	0.179	0.187	0.183	0.051	0.059	0.057	0.062	0.068	0.065	0.09	0.10	0.09

T1 = Control; T2 = NPK kg/ha (90:60:40); T3 = FYM (18 t/ha); T4 = Vermicompost (3.6 t/ha); T5 = Biofertilizer (Azotobacter + PSB); T6 = 75% (NPK) + FYM (4.5 t/ha); T7 = 75 % (NPK) + Vermicompost (0.9 t/ha); T8 = 75% (NPK) + Biofertilizer (Azotobacter + PSB);
T9 = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha); T10 = 75% (NPK) + FYM (4.5 t/ha) + Biofertilizer (Azotobacter + PSB);
T11 = 75% (NPK) + Vermicompost (0.9 t/ha) + Biofertilizer (Azotobacter + PSB);
T12 = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha) + Biofertilizer (Azotobacter + PSB)

Table 3. Effect of integrated nutrient management on nitrogen content (%) and uptake (kg ha^{-1}) of sweet corn at harvest

Treatments	Nitrogen content			Nitrogen uptake		
	2013	2014	Mean	2013	2014	Mean
T1	0.88	0.86	0.87	82.82	79.48	81.14
T2	1.10	1.11	1.11	193.12	197.84	195.47
T3	0.98	1.04	1.01	169.95	183.66	176.76
T4	1.02	1.06	1.04	175.59	188.57	182.03
T5	1.04	1.08	1.06	175.05	185.28	180.14
T6	1.01	1.07	1.04	173.34	185.22	179.25
T7	1.03	1.06	1.05	178.04	185.20	181.61
T8	1.05	1.09	1.07	178.66	188.73	183.67
T9	1.09	1.11	1.10	190.96	196.97	193.95
T10	1.15	1.17	1.16	217.83	226.04	221.92
T11	1.11	1.12	1.12	200.27	205.43	202.84
T12	1.12	1.13	1.13	205.13	211.88	208.50
SEm±	0.013	0.013	0.013	3.132	3.534	3.353
CD (p=0.05)	0.04	0.04	0.04	9.24	10.46	9.92

T1= Control; T2 = NPK kg/ha (90:60:40); T3 = FYM (18 t/ha); T4 = Vermicompost (3.6 t/ha); T5 = Biofertilizer (Azotobacter + PSB); T6 = 75% (NPK) + FYM (4.5 t/ha); T7 = 75% (NPK) + Vermicompost (0.9 t/ha); T8 = 75% (NPK) + Biofertilizer (Azotobacter + PSB); T9 = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha); T10 =75% (NPK) + FYM (4.5 t/ha) + Biofertilizer (Azotobacter + PSB); T11 = 75 % (NPK) + Vermicompost (0.9 t/ha) + Biofertilizer (Azotobacter + PSB); T12 = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha) + Biofertilizer (Azotobacter + PSB)

Table 4. Effect of integrated nutrient management on phosphorus content (%) and uptake (kg ha^{-1}) of sweet corn at harvest

Treatments	Phosphorus content			Phosphorus uptake		
	2013	2014	Mean	2013	2014	Mean
T1	0.19	0.18	0.19	17.88	16.64	17.25
T2	0.22	0.23	0.23	38.62	40.99	39.80
T3	0.20	0.20	0.20	34.68	35.32	35.00
T4	0.20	0.21	0.21	34.43	37.36	35.88
T5	0.21	0.22	0.22	35.35	37.74	36.54
T6	0.21	0.21	0.21	36.04	36.35	36.20
T7	0.22	0.22	0.22	38.03	38.44	38.23
T8	0.23	0.24	0.24	39.13	41.56	40.34
T9	0.24	0.24	0.24	42.05	42.59	42.32
T10	0.25	0.26	0.26	47.36	50.23	48.78
T11	0.24	0.24	0.24	43.30	44.02	43.66
T12	0.24	0.25	0.25	43.96	46.88	45.41
SEm±	0.004	0.004	0.004	0.837	0.913	0.872
CD (p=0.05)	0.011	0.013	0.012	2.47	2.69	2.58

T1 = Control; T2 = NPK kg/ha (90:60:40); T3 = FYM (18 t/ha); T4 = Vermicompost (3.6 t/ha); T5 = Biofertilizer (Azotobacter + PSB); T6 = 75% (NPK) + FYM (4.5 t/ha); T7 = 75 % (NPK) + Vermicompost (0.9 t/ha); T8 = 75% (NPK) + Biofertilizer (Azotobacter + PSB); T9 = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha); T10 = 75% (NPK) + FYM (4.5 t/ha) + Biofertilizer (Azotobacter + PSB); T11 = 75 % (NPK) + Vermicompost (0.9 t/ha) + Biofertilizer (Azotobacter + PSB); T12= 75 % (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha) + Biofertilizer (Azotobacter + PSB)

Table 5. Effect of integrated nutrient management on potassium content (%) and uptake (kg ha^{-1}) of sweet corn at harvest

Treatments	Potassium content			Potassium uptake		
	2013	2014	Mean	2013	2014	Mean
T1	0.98	0.97	0.98	92.23	89.65	90.94
T2	1.10	1.11	1.11	193.12	197.84	195.47
T3	1.03	1.07	1.05	178.62	188.96	183.76
T4	1.04	1.06	1.05	179.04	188.57	183.78
T5	1.05	1.08	1.07	176.74	185.28	180.99
T6	1.09	1.11	1.10	187.07	192.14	189.60
T7	1.11	1.12	1.12	191.86	195.69	193.78
T8	1.12	1.14	1.13	190.57	197.39	193.96
T9	1.14	1.16	1.15	199.72	205.84	202.77
T10	1.17	1.18	1.18	221.62	227.98	224.79
T11	1.13	1.14	1.14	203.87	209.10	206.48
T12	1.14	1.15	1.15	208.79	215.63	212.20
SEm$\pm$	0.007	0.007	0.007	3.466	3.939	3.728
CD (p=0.05)	0.021	0.023	0.022	10.25	11.65	11.03

T1 = Control; T2 = NPK kg/ha (90:60:40); T3 = FYM (18 t/ha); T4 = Vermicompost (3.6 t/ha); T5 = Biofertilizer (Azotobacter + PSB); T6 = 75% (NPK) + FYM (4.5 t/ha); T7 = 75% (NPK) + Vermicompost (0.9 t/ha) T8 = 75% (NPK) + Biofertilizer (Azotobacter + PSB); T9 = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha); T10 = 75% (NPK) + FYM (4.5 t/ha) + Biofertilizer (Azotobacter + PSB); T11 = 75% (NPK) + Vermicompost (0.9 t/ha) + Biofertilizer (Azotobacter + PSB); T12 = 75% (NPK) + FYM (2.25 t/ha) + Vermicompost (0.45 t/ha) + Biofertilizer (Azotobacter + PSB)

4. CONCLUSION

Two year investigations on "Influence of integrated nutrient management on yield and quality of sweet corn (*Zea mays* var. *saccharata*) under temperate conditions of Kashmir' revealed that application of 75% (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB) proved significantly superior in terms of quality parameters viz., sugar, starch, vitamin C, protein content and NPK content and uptake as against unfertilized control and various other treatments. In view of this, it may be concluded that for obtaining maximum of the above mentioned traits of sweet corn, it needs to be fertilized with 75% (NPK) + FYM (4.5 t ha^{-1}) + Biofertilizer (*Azotobacter* + PSB). However, before giving final recommendations, the investigation needs to be carried out at different agro-climatic regions of the Valley to arrive at final conclusions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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