International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 3244-3247

Received: 23-05-2018
Accepted: 26-06-2018

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Determination of quality of baby corn (*Zea mays* L.) under the effect of integrated nutrient management

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Abstract
The demand of baby corn is increasing day by day in countries like USA, Japan, Singapore, Australia, Canada, New Zealand and Arab countries. Baby corn has a great potential to fetch foreign currency through international trade. There is a great demand of baby corn in international market mainly because of its freshness, taste, nutrition, free from pesticides and its multiuse. It is also considered as a green food. Thus the quality of baby corn is of utmost importance to keep it up to the international standards. The present study was thus carried out during *Kharif* season 2015 at the Instructional Dairy Farm (IDF), Nagla, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand to analyse the growth of baby corn under the effect of integrated nutrient management. The experimental design was Randomized Block Design with 11 treatments consisting of sole application of NPK fertilizer, sole application of *Azotobacter* and *Azospirillum*, and application of *Azotobacter* and *Azospirillum* along with NPK fertilizer. As a result, different integrated nutrient management practices were found to have significant effect on TSS of baby corn only at 4th pick and on an average values, however 75% NPK+*Azos*+*Azot* gave significantly higher TSS content. The protein content was also significantly affected by different integrated nutrient management practices with the highest value at application of 100% NPK+*Azot*+*Azos* that remained non significant with 100% NPK and 75% NPK+*Azot*+*Azos* treatments. The results of sensory evaluation of baby corn revealed that the baby corn produced at application of 100% NPK+*Azot*+*Azos* were liked extremely by 80% of the respondents mainly because of more juicyness and sweetness, whereas 75% NPK+*Azot*+*Azos* treatment baby corn were liked extremely by 70 percent respondents. The baby corns of *Azotobacter* treated plot were liked very much by 40%, liked moderately by 30% and liked slightly by 30% of the respondents. The combined application of chemical fertilizers and biofertilizers thus played good role in improving baby corn quality.

Keywords: *Azotobacter, azospirillum,* sensory evaluation, total soluble solids, protein content

Introduction
Presently baby corn is gaining popularity among Indian farming communities mainly due to its short duration, high market rate, nutritive value and also its multiuse. Baby corn is dehusked immature maize ear, harvested within 2-3 days of silking but prior to fertilization (Pandey *et al*., 1998) [7]. The desirable size of baby corn is 6-11 cm length and 1-1.5 cm diameter with regular row/ovule arrangement. The most preferred colour by the consumer is generally creamish to very light yellow (Pal, 2011) [6]. Baby corn is used as *vegetable*, *salad*, *soup*, *pickle*, *kheer*, *murabba*, *chutney*, *manchurian*, *halwa* etc. Baby corn is highly nutritive as 100 g of baby corn contains 89.1% moisture, 0.2 g fat, 1.9 g protein, 8.2 mg carbohydrate, 0.06 g ash, 28.0 mg calcium, 86.0 mg phosphorus, 11.0 mg ascorbic acid (Das *et al*., 2009) [2]. Besides, nutritive advantage, it is also free from residual effect of pesticides mainly because of the young cobs are wrapped up tightly with husk and well protected from enemies and also giving very little time for infestation to diseases and insect-pests, whereas other vegetables cannot be grown without the protected umbrella of pesticides and insecticides. Baby corn has a great potential to fetch foreign currency through international trade. There is a great demand of baby corn in international market mainly because of its freshness, taste, nutrition, free from pesticides and its multiuse. Therefore it is also considered as a green food. The net income from baby corn is four to five times higher from a single crop than grain maize crop. In addition, the net income from baby corn can be multiplied by growing of 3-4 crops of baby corn in a year.

Due to increasing awareness about health coupled with high income the demand of baby corn is increasing in Indian market. Thus the quality of baby corn is of utmost importance to keep it up to the international standards. And keeping in view the high nutrient requirement of baby corn, the way nutrient requirement of baby corn is fulfilled is thought to have significant effect on baby corn quality.

Inoculation of seeds with *Azotobacter chroococcum* increased carbohydrate and protein content of two varieties of corn i.e. Inra210 and Inra260 in greenhouse experiment (Kizilog *et al.*, 2001) [5]. Khan *et al.* (2008) [4] reported that seed protein content of maize was maximum at application of 300 kg N ha^{-1} and also the increase in N applications increased the kernel protien content. Reddy and Bhanumurthy (2010) [9] studied the effect of three nitrogen levels i.e., 120, 180 and 240 kg N ha^{-1} on crude protein of forage maize and found that 240 kg N ha^{-1} gave significantly higher crude protein content. Singh *et al.* (2010) [8] observed significant increase in baby corn and green fodder yield and quality parameters (carbohydrate, sugar, starch and protein) with application of 120kg N ha^{-1}. Bisht (2011) [1] reported that protein, lysine and tryptophan content in grains of Quality Protein Maize remained unaffected due to integration of 25 or 50% recommended nitrogen by vermicompost with 75 and 50% recommended nitrogen through chemical fertilizers compared to alone application of chemical fertilizers. Keerthi *et al.* (2013) [3] observed that the application of 180-75-60 NPK kg ha^{-1} + vermiwash resulted in significantly higher protein content in maize grain compared to application of 180-75-60 NPK kg ha^{-1} + 30 kg N ha^{-1} through vermicompost and control. Integrated nutrient management thus is a potential option to fulfill nutrient requirement of baby corn and the present study is carried out to determine the effect of integrated nutrient management on quality of baby corn.

Material and Methods

The experiment was conducted at the Instructional Dairy Farm (IDF), Nagla, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India. The Instructional Dairy Farm is located in the *Tarai* belt of Shivalik range of Himalayas with humid sub-tropical type of climate at latitude of 29°N and longitude of 79.3°E and situated at an altitude of 243.84 m above the mean sea level. The climate of the *Tarai* region is broadly humid sub-tropical with harsh winter and hot dry summers. The soil of the experimental field was slightly silty clay loam (Nagla series, Mollisol) in texture, from dark greyish brown to dark grey in humus with weak, fine to medium granular structure.

Eleven treatments were tested in a Randomized Block Design 3 replications the treatments were Control (no application), 50% NPK, 100% NPK(180:60:40), Seed treatment with Azotobacter @200g/10Kg seeds, Seed treatment with Azospirillum @200g/10Kg seeds, Seed treatment with Azospirillum + Azotobacter, 50% NPK + Seed treatment with Azotobacter, 50% NPK + Seed treatment with Azospirillum, 50% NPK+ Seed treatment with Azospirillum + Azotobacter, 50% NPK+ Seed treatment with Azospirillum + Azotobacter and 100%NPK+seed treatment with Azospirillum + Azotobacter. The variety sown was V.L. Baby corn-1 – released from Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand.

Results and Discussion

Total Soluble Solids (TSS)

The highest TSS was recorded with 75% NPK+*Azot*+*Azos* except at 3rd picking where 100% NPK+*Azot*+*Azos* had the highest value. TSS value at 4th pick as well as on an average value was found significantly higher under 75% NPK+*Azot*+*Azos* and it remained statistically at par with 100% NPK+*Azot*+*Azos*, 100% NPK, 50% NPK+*Azot*, 50% NPK+*Azot*+*Azos*. The results revealed that chemical as well as biofertilizer application improved the TSS values due to synergistic effect of nitrogen due to *Azotobacter* and *Azospirillum*. The data pertaining to TSS is given in table 1.

Nitrogen and protein content

At 1st, 2nd, 3rd and 4th pick highest nitrogen content was recorded with application of 100% NPK+*Azot*+*Azos*, 100% NPK, 75% NPK+*Azot*+*Azos* and 50% NPK+*Azos*, respectively. On an average values, seed treatment with *Azot*+*Azos* had the highest N content than seed treatment with *Azotobacter* and *Azospirillum* though both were remained non significant. The 50% NPK had significantly lower N content than 50% NPK + Biofertilizers, while 50% NPK+*Azot*+*Azos* had the higher N content than 50% NPK+*Azos* and 50% NPK+*Azot* but the treatments were remained non significant amongselves. Higher content of nitrogen at higher dose was because of higher availability of nitrogen to crop plants.

At 1st, 2nd, 3rd and 4th pick highest protein was recorded with application of 100% NPK+*Azot*+*Azos*. An average protein content also indicated that seed treatment with either alone or combined i.e., *Azot*+*Azos* had significantly equal protein content. Similarly, combined application of 50% NPK + Biofertilizers again had significantly equal protein content. The increase in protein content due to inoculation of seeds with biofertilizers and higher dose of nitrogen leads to release of plant growth promoting bacteria which caused higher availability of nutrients and increased the biochemical reactions which in turn increased the protein content. The data pertaining to nitrogen and protein content is given in figure 1.

Sensory evaluation using Nine – Point Hedonic Scale

The baby corn produced under 100% NPK+*Azot*+*Azos* were extremely liked by 80% and liked very much by 20% of the respondents mainly because the baby corns were found more sweet and juicy, while baby corns of 75% NPK+*Azot*+*Azos* were extremely preferred by 70% and liked very much by 30% of the respondents. The baby corns harvested from seed treatment with *Azotobacter* were liked very much by 40%, moderately liked by 30% and slightly liked by 30% of the respondents, while *Azospirillum* treated baby corns were liked very much by 30%, moderately liked by 50% and slightly liked by 20% of the respondents. The results were very encouraging when the baby corns were received from the plot where both biofertilizers were treated because 20% of the respondents extremely liked, 50% liked very much and 30% liked moderately. In general, results revealed that both nitrogen and biofertilizers played a significant role in improving the taste and likeliness by the respondents. The preference and likeliness of the baby corn might be based on the taste, sweetness and juicyness. Hence, higher dose of nitrogen and biofertilizer improved the availability of nutrients resulting into higher uptake of nitrogen and other nutrients that might have improved the taste and sweetness of the baby corn. The data pertaining to nitrogen and protein content is given in table 2.

Conclusion

The study revealed that combined application of chemical fertilizers and biofertilizers played a significant role in improving the quality of baby corn in terms of nitrogen content, protein content, total soluble solids value, taste and sweetness.

Table 1: Effect of integrated nutrient management on total soluble solids at harvest

Treatment	TSS (%)					
	1st pick	2nd pick	3rd pick	4th pick	5th pick	Average
Control	7.7	7.7	8.0	9.0	7.7	8.1
Azotobacter	7.7	7.7	8.3	9.0	9.0	8.3
Azospirillum	7.7	7.7	8.3	9.0	8.3	8.2
Azot +Azos	7.7	8.0	8.7	9.3	9.0	8.5
50% NPK	8.0	8.0	8.7	10.0	9.7	8.9
100% NPK	8.3	8.7	9.3	10.7	10.0	9.4
50% NPK + *Azotobacter*	8.0	8.3	9.0	10.0	9.7	9.0
50% NPK +*Azospirillum*	8.0	8.0	9.0	10.0	9.7	8.9
50% NPK + *Azot+ Azos*	8.0	8.3	9.0	10.7	10.0	9.2
75% NPK + *Azot+ Azos*	8.7	8.7	9.7	11.0	10.0	9.6
100% NPK + *Azot + Azos*	8.3	8.7	10.0	10.7	10.0	9.5
SEm±	0.4	0.4	0.5	0.4	0.6	0.2
LSD (p=0.05)	Ns	ns	ns	1.0	Ns	0.6

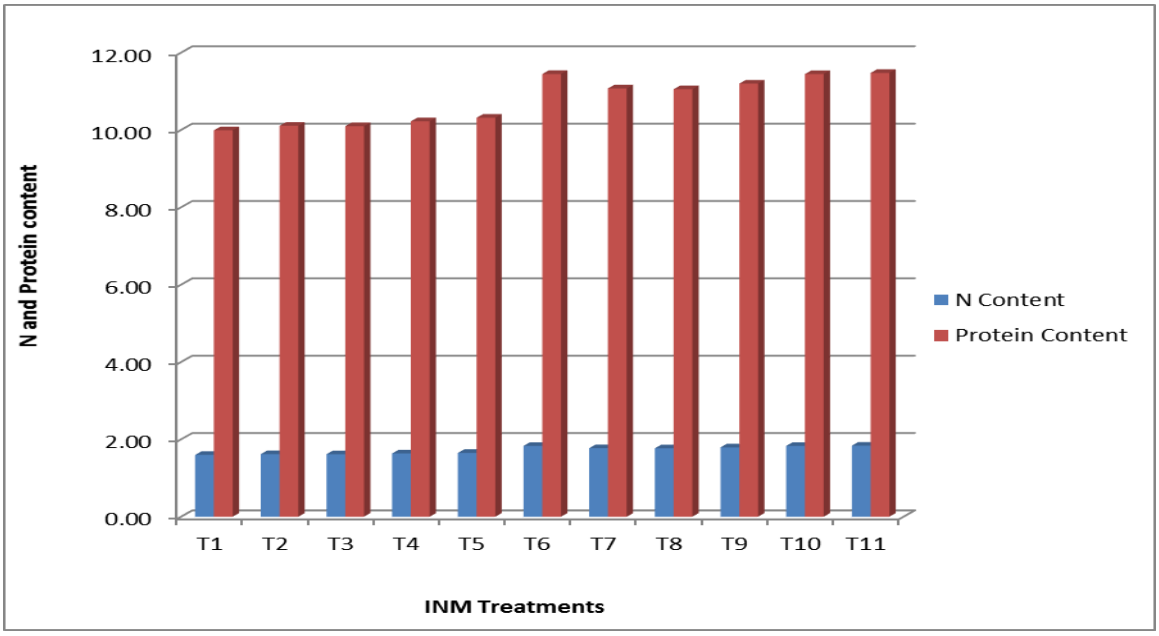

Fig 1: Effect of integrated nutrient management on nutrient and protein content.

Table 2: Effect of integrated nutrient management on sensory evaluation of baby corns using Nine-Point Hedonic scale

Treatment	Nine-Point Hedonic Rating								
	Liked extremely	Liked very much	Liked moderately	Liked slightly	Neither like nor dislike	Disliked slightly	Disliked moderately	Disliked very much	Disliked extremely
Control	-	30% (3)	40% (4)	10% (1)	10% (1)	10% (1)	-	-	-
Azotobacter	-	40% (4)	30% (3)	30% (3)	-	-	-	-	-
Azospirillum	-	30% (3)	50% (5)	20% (2)	-	-	-	-	-
Azot +Azos	20% (2)	50% (5)	30% (3)	-	-	-	-	-	-
50% NPK	10% (1)	40% (4)	50% (5)	-	-	-	-	-	-
100% NPK	30% (3)	60% (6)	10% (1)	-	-	-	-	-	-
50% NPK + *Azotobacter*	60% (3)	40% (4)	-	-	-	-	-	-	-
50% NPK + *Azospirillum*	40% (4)	30% (3)	30% (3)	-	-	-	-	-	-
50% NPK + *Azot+ Azos*	30% (3)	60% (6)	10% (1)	-	-	-	-	-	-
75% NPK + *Azot+ Azos*	70% (7)	30% (3)	-	-	-	-	-	-	-
100% NPK + *Azot + Azos*	80% (8*)	20% (2)	-	-	-	-	-	-	-

* No. of people

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