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Garima Joshi
GBPUAT, Pantnagar, Uttarakhand, India

Aaradhana Chilwal
PAU, Ludhiana, Punjab, India

Correspondence
Aaradhana Chilwal
PAU, Ludhiana, Punjab, India

Studies on integrated nutrient management for nutrient content and uptake in baby corn (*Zea mays* L.)

Garima Joshi and Aaradhana Chilwal

Abstract
Integrated Nutrient Management (INM) refers to judicious application of different nutrient sources in balanced proportion for sustaining soil and crop productivity. Biofertlizers are an important component of integrated nutrient management system because of its significant role in sustaining the soil properties and increasing nutrient availability. Nutrient management is of great importance for higher baby corn production as it responds to higher doses of fertilizer. In addition, better nutrient content and uptake leads to higher yield. 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 nutrient content and uptake in 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. The study revealed that N, P and K content of baby corn increased with increasing level of chemical as well as biofertilizers and significantly higher N, P and K content of baby corn was recorded at application of 100% NPK+*Azot+Azos*. Green fodder had higher N and K content at application of 100% NPK+*Azot+Azos*, whereas the P content remained non significant with highest value at 100% NPK+*Azot+Azos*. Significantly higher N, P and K uptake was recorded at application of 100% NPK+*Azot+Azos* that remained non significant with 75% NPK+*Azot+Azos* at K uptake. But the N, P and K uptake in green fodder was found significantly higher at application of 100% NPK+*Azot+Azos* that remained non significant with 75% NPK+*Azot+Azos* and 100% NPK for N and P uptake and 75% NPK+*Azot+Azos* for K uptake. Highest total N, P and K uptake was found at 100% NPK+*Azot+Azos* that remained non significant with 75% NPK+*Azot+Azos* for total N and K uptake. Thus, INM in baby corn is of immense importance for higher nutrient content and uptake.

Keywords: *Azotobacter, azospirillum*, nutrient uptake, nutrient content, integrated nutrient management

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. It responds to higher doses of fertilizer that may normally cause lodging in other cereal crops. Thus nutrient management is a very important aspect for proper growth of baby corn. Arya and Singh (2000) [1] reported that application of 90 kg P_2O_5 ha^{-1} resulted in significantly higher grain and straw yield, nutrient uptake and protein yield of maize compared to 60, 30 and 0 kg P_2O_5 ha^{-1}. Rekhi *et al.* (2000) [6] reported that the continuous application of 150% NPK or their combinations with organic manures in maize - wheat cropping system, increased the available P from initial 3 mg/kg soil to 11.5 mg/kg soil. Application of 90 kg N ha^{-1} recorded higher agronomic efficiency of nitrogen (20.01 mg/kg N) compared to 45 kg N (32.5 mg/kg N) in maize. Further, it was enhanced when N was applied along with FYM at 15 tonnes ha^{-1} (24.07 mg/kg N. Tolessa *et al.* (2001) [8] conducted field experiment in *Alfisols* of Bangalore and results indicated that the application of enriched FYM along with nitrogen at 150 kg ha^{-1} enhanced N (233 kg ha^{-1}), P_2O_5 (73.3 kg ha^{-1}) and K_2O (238 kg ha^{-1}) uptake by maize. Sutaliya and Singh (2005) [7] from Varanasi reported that fertility level up to 180, 90 and 60 kg N, P_2O_5 and K_2O ha^{-1} significantly improved the yield and yield attributes of maize. The uptake of NPK (188.1, 59.1 and 247.7 kg ha^{-1}, respectively) also increased with increased NPK levels. Kar *et al.* (2006) [2] revealed that application of 80 kg N ha^{-1} resulted in significant increased of sweet corn nutrients uptake.

Application of 120 kg N ha^{-1} resulted in significantly higher grain yield (5432 kg ha^{-1}) and stover yield (5962 kg ha^{-1}), nutrient content, total NPK uptake (150.3, 31.4 and 189.17 kg ha^{-1}) and protein content (10.44%) of maize as compared to 80, 40 and 0 kg N ha^{-1} (Omraj *et al.,* 2007) [4]. Seed Inoculated with *Azotobacter* helps in uptake of N, P along with micronutrients like Fe and Zn, in wheat, these strains can be used potentially to improve wheat nutrition (Rajaee *et al.*, 2007) [5]. *Azotobacter* improves availability of nutrients like carbon, nitrogen, phosphorus and sulphur through accelerating the mineralization of organic residues in soil and avoid the uptake of heavy metals (Lévai *et al.,* 2008) [3]. These studies revealed the importance of integrated nutrient management in improving nutrient content and uptake. But little research work has been done so far on integrated nutrient management including use of biofertilizers alone or in combination of chemical fertilizers and its effect on nutrient content and uptake. Thus the present study was carried out to find out the best integrated nutrient management practice for baby corn under which the crop would show best results in terms of nutrient content and uptake.

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

Nutrient Content

N content

The treatment with 100% NPK+*Azot*+*Azos* had significantly higher N content in baby corn and it was statistically at par with 75% NPK+*Azot*+*Azos* and 100% NPK. The N content increased with application of either biofertilizer or chemical fertilizers. It was also clear that combined application of chemical fertilizers with alone seed treatment with biofertilizer or combuned improved the N content in baby corn. Siginficantly higher N content in green fodder was recorded under 100% NPK+*Azot*+*Azos* followed by 100% NPK, 50% NPK+*Azot*+*Azos* and 75% NPK+*Azot*+*Azos* and remained non significant with each other. The seed treatment with *Azotobacter* and *Azospirillum* being non significant to each other. Higher content of nitrogen at higher dose is because of higher availability of nitrogen in soil solution.

P content

The P content in baby corn was recorded significantly higher under 100% NPK+*Azos*+*Azot* that was significantly similar to 75% NPK+*Azot*+*Azos* and 100% NPK. The 50% NPK had significantly lower P content than 50% NPK coupled with biofertilizers, however 50% NPK+*Azot*+*Azos* gave higher P content. P content in green fodder did not differ significantly among all the treatments but the highest value was found with 100% NPK+*Azot*+*Azos* followed by 50% NPK+*Azot*+*Azos* and 100% NPK.

K content

The K content in baby corn was recorded significantly higher under 100% NPK+*Azot*+*Azos* that remained significantly at par with 100% NPK, 50% NPK+*Azot*, 50% NPK+*Azos*, Signficantly highest K content in green fodder was recorded with application of 100% NPK+*Azot*+*Azos* followed by 75% NPK+*Azot*+*Azos* that remained non significant with 100% NPK. Among the alone application of the biofertilizer seed treatments, *Azospirillum* gave significantly lowest K content while *Azot*+*Azos* had the highest K content in green fodder. Data pertaining to nutrient content is given in Table 1.

Nutrient uptake

N uptake

The treatment with application of 100% NPK+*Azot*+*Azos* had significantly higher nitrogen uptake that remained non significant with 75% NPK+*Azot*+*Azos*. Among the biofertilizer treatments, the seed treatment with *Azotobacter* +*Azospirillum* gave significantly higher nitrogen uptake followed by seed treatment with *Azotobacter*. The higher nitrogen uptake was attributed to higher baby corn yield as well as its nitrogen content. In green fodder and total N uptake was found highest with application of 100% NPK+*Azot*+*Azos* that remained significantly at par with 100% NPK and 75% NPK+*Azot*+*Azos*.

P uptake

The highest and the lowest phosphorus uptake was recorded with application of 100% NPK+*Azot*+*Azos* and control, respectively. Among the biofertilizer treatments, the seed treatment with *Azos*+*Azot* had higher phosphorus uptake followed by seed treatment with *Azotobacter*. The treatment with100% NPK+*Azot*+*Azos* recorded the highest green fodder P uptake. The application of 100% NPK+*Azot*+*Azos* had the highest total P uptake followed by 75% NPK+*Azot*+*Azos* and 100% NPK, but both treatment did not differ significantly with each other.

P uptake

The potassium uptake of baby corn was recorded significantly higher with application of 100% NPK+*Azot*+*Azos* that remained non significant with 75% NPK+*Azot*+*Azos*. Among the biofertilizer treatments, the highest potassium uptake was recorded at seed treatment with *Azos*+*Azot* followed by seed treatment with *Azotobacter*. The potassium uptake of green fodder and total potassium uptake was recorded significantly higher with application of 100% NPK+*Azot*+*Azos* that remained non significant with 75% NPK+*Azot*+*Azos*. The seed treated with *Azospirillum* gave lesser K uptake than seed treatment with *Azotobacter* but both treatments had significantly equal K uptake.

The integrated use of chemical and biofertilizers might have released in sufficient amount of nutrients by mineralization at a constant level, would have accelerated the mineralization of organic residues in soil and avoided the uptake of heavy metals and thud increased the nutrient uptake because of the better soil environment created owing to cumulative effect of organic sources combined with inorganic source of nutrients.

Data pertaining to nutrient uptake is given in Table 2.

Conclusion

Integrated nutrient management successfully increased the nutrient content and uptake in baby corn as an effect of accelerated mineralization of nutrients and by creating better soil environment.

Table 1: Effect of integrated nutrient management on N, P and K content in baby corn and green fodder

Treatment	N content (%)		P content (%)		K content (%)	
	Corn	Green Fodder	Corn	Green Fodder	Corn	Green Fodder
Control	1.60	1.79	0.34	0.20	0.51	2.22
Azotobacter	1.62	1.80	0.38	0.20	0.61	2.46
Azospirillum	1.62	1.80	0.37	0.21	0.56	2.33
Azot +Azos	1.64	1.84	0.44	0.21	0.65	2.57
50% NPK	1.65	1.83	0.45	0.22	0.70	2.57
100% NPK	1.83	1.88	0.55	0.24	0.77	2.91
50% NPK + *Azotobacter*	1.77	1.85	0.53	0.22	0.75	2.63
50% NPK +*Azospirillum*	1.77	1.84	0.52	0.22	0.74	2.59
50% NPK + *Azot+ Azos*	1.79	1.88	0.54	0.24	0.77	2.77
75% NPK + *Azot+ Azos*	1.83	1.88	0.56	0.23	0.77	2.94
100% NPK + *Azot + Azos*	1.84	1.90	0.58	0.25	0.78	3.05
SEm±	0.01	0.01	0.01	0.04	0.01	0.03
LSD (p=0.05)	0.01	0.05	0.03	ns	0.04	0.10

Table 2: Effect of integrated nutrient management on N, P and K uptake in baby corn and green fodder

Treatment	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
	Baby Corn	Green fodder	Total	Baby Corn	Green fodder	Total	Baby Corn	Green fodder	Total
Control	2.7	19.5	22.2	0.6	2.2	2.8	0.9	24.2	25.1
Azotobacter	3.6	30.3	33.9	0.9	3.4	4.3	1.4	41.4	42.8
Azospirillum	3.1	27.7	30.8	0.7	3.2	3.9	1.1	35.8	36.9
Azot +Azos	4.1	32.2	36.3	1.1	3.7	4.8	1.6	45.0	46.6
50% NPK	4.8	36.1	40.9	1.3	4.3	5.6	2.0	50.5	52.5
100% NPK	7.0	49.6	56.6	2.1	6.3	8.4	3.0	77.0	80.0
50% NPK + *Azotobacter*	6.1	42.8	48.9	1.8	5.1	6.9	2.6	61.0	63.6
50% NPK +*Azospirillum*	5.9	39.1	45.0	1.7	4.7	6.4	2.5	55.0	57.5
50% NPK + *Azot+ Azos*	6.4	45.9	52.3	1.9	5.9	7.8	2.8	67.5	70.3
75% NPK + *Azot+ Azos*	7.3	51.4	58.7	2.2	6.3	8.5	3.1	80.2	83.3
100% NPK + *Azot + Azos*	7.6	52.7	60.3	2.4	6.9	9.3	3.2	84.6	87.8
SEm±	0.1	1.4	1.4	0.5	0.2	0.2	0.6	2.0	1.9
LSD (p=0.05)	0.4	4.2	4.1	0.2	0.6	0.6	0.2	5.9	5.8

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