Journal of Integrated Research
Vol. 1, No. 1, July 2023 – June 2024
Website : https://journalofintegratedresearch.com/

Yield, Content and Nutrients Uptake affected by IPNS for maize (*Zea mays*) crop under inceptisol of Bulandshahar (U.P.)

P.P.Singh[1], N.L.Sharma[1] and R. Meena[2]

[1]*Department of Soil Science, A.S (P.G.) College, Lakhaoti, Bulandshahar (U.P.)*

[2] *Asst. Professor Deptt of Soil Sci. and Agricultural Chemistry BHU, Varanasi.*

ABSTRACT

A field experiment was conducted at Agricultural Research Farm of Amar Singh (P.G.) College, Lakhaoti, Bulandshahar to know response of IPNS on yield, nutrient content and uptake by maize crop. The grain yield (average of two year) ranged from 33.13 to 52.56 q ha^{-1}, strover yield 40.32 to 60.76 q ha^{-1} and total biological yield 73.44 to 113.32 q ha^{-1} where maximum yield of maize was produced by application of nutrients through 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers **(**T_3**)**. Nutrient contents under integrated plant nutrient supply (IPNS) of maize crop was observed maximum 1.51, 0.45 and 0.59 percent NPK respectively, in grain and 0.98, 0.705 and 1.80 percent NPK respectively, in stover through application of nutrients by 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers (T_3). Similarly, in case of nutrients uptake by maize crop was found maximum 79.37, 23.66 and 30.74 kg ha^{-1} NPK respectively through grains while 59.24, 42.83 and 109.37 kg ha^{-1} NPK respectively, through stover of maize crop under treatment T_3 (10 tonnes ha^{-1} FYM + Rest through chemical fertilizers). In these parameters, significant increase was recorded in the treatments received organic, inorganic and bio-fertilizer sources of nutrients in combined form.

Key words: IPNS, chemical fertilizers, bio-fertilizers, maize, content, uptake.

Introduction

Maize (*Zea mays* L.), as a source of carbohydrate is well known crop grown in kharif season in India. Maize is one of the most important cereal crops in India. With the introduction of improved varieties and improved techniques to grow maize particularly the

hybrids/composites, a wider spacing is recommended for it. Thus, there is ample scope to utilize the vacant inter-row space of maize by introducing some compatible crops **(Singh and Singh, 1993)**. Intercropping with legumes may maintain the system in a positive nitrogen balance and if there is good growth of legumes, the nitrogen contribution can be significant. **Shivay *et. al.* (2001)** observed significantly higher 1000 grain weight of maize under urd-bean and soybean intercropping than sole maize. Thus, for higher productivity and improvement in soil fertility for longer period, integrated plant nutrient management system (IPNS) has become important. The principal aim of IPNS is efficient and judicious use of all the major sources of plant nutrients in an integrated manner, so as to get maximum economic yield without any deleterious effects on physico-chemical and biological properties of the soil.

Materials & Methods

An experiment was conducted during the kharif season at the Agricultural Research Farm of Amar Singh (P.G.) College, Lakhaoti (Bulandshahar). The Research Farm is situated about 15 km away from Bulandshahr on Bulandshahr-Garh road. Bulandshahr, located in western Uttar Pradesh, is the most fertile and suitable belt of Doab of Ganga and Yamuna for cereals and vegetables. It lies between 28^0 N latitude and 77' E longitude at an elevation of about 201.48 m above mean sea level. The average annual rainfall of this region is 703.75 mm. About 88% of rainfall is received from June to September and the remaining (20%) during October to March. May and June are the hottest months of the year and maximum temperature ranges between 43-45^0C while January is the coldest month with minimum temperature ranging between 3-6^0C. Treatments description are $\mathbf{T_1}$: Recommended dose of NPK (120: 60:40), $\mathbf{T_2}$: Fertilizer dose based on soil test value, $\mathbf{T_3}$: 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers, $\mathbf{T_4}$: Azotobacter + 75% N and full dose of P & K through chemical fertilizers, $\mathbf{T_5}$: Rhizobium + 50% P and full dose of N & K through chemical fertilizers, $\mathbf{T_6}$: PSB (Phosphorus solubilizing bacteria) + 75% P and full dose of N & K through chemical fertilizers, $\mathbf{T_7}$: *Azotobacter* + *Rhizobium* + PSB + 75% N, 25% P and 100% K through chemical fertilizers, $\mathbf{T_8}$: *Azotobacter* + *Rhizobium* + PSB + 10 t ha^{-1} FYM and 33% N, no P and K through chemical fertilizers, $\mathbf{T_9}$: 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK. Fertilizers namely Urea (46% N), DAP (48% P) and MOP (60% KCl) were used as a source of nitrogen, phosphorus and potassium

respectively, in the form of chemical fertilizers. FYM was also used as a source of nitrogen, phosphorus, potassium and mirco-elements in the form of organic manure. The microbial culture of *Azotobacter (A. chroococcum)*, PSB *(Bacillius* and *Pseudomonas*) & *Rhizobium* were used as bio-fertilizers.

All the cobs of each plot were weighed and multiplied with the shelling percentage and fixed the yield on 15 percent moisture by factor. The grain yield was calculated by the formula given below:

$$\text{Grain yield (kg / net plot)} = \frac{\text{Fresh Weight of cob (100 – moisture\%) x shelling\% x 1.176}}{100}$$

This grain yield was converted by multiplying the factor and reported as grain yield of q ha^{-1}. After removal of cobs from the stalks manually, remaining produce weight was recorded and reported as q ha^{-1}. After removal of cobs from the stalks manually remaining produce weight was recorded and reported as q ha^{-1}. The biological yield was presented by produce (grain + straw) of each net plot was allowed to air dry in the field after harvesting and weighed and reported as biomass of net plot in q ha^{-1}. Nitrogen was determined by micro Kjeldhal method **(Jackson, 1958)**. The Kjeltec auto analyzer was used for analysis. It was expressed in percentage on dry weight basis. Phosphorus content in digested plant samples was determined by vanado molybdate phosphoric acid and readings were read at spectrophotometer at 470 wavelength as described by Champman and Parker (1961). Potassium content of plant samples was determined by flame photometer (mediflame) at 786 µm **(Jackson, 1958)**. The data was tabulated and processed to suit for computerization and analysis of variance, by method as given by **Snedecor and Cochran (1968)**.

Result and Discussion

yield

Highest grain yield of maize (51.74 q/ha during 1st year and 53.38 q/ha during 2nd year) was recorded from the treatment T_3 (FYM + Chemical fertilizer). In this treatment grain yield was recorded significant higher over rest of the treatment during both the years. Maize yield was recorded lowest (31.14 q/ha during 1st year and 35.11 q/ha during 2nd year) in the treatment T_9

Journal of Integrated Research
Vol. 1, No. 1, July 2023 – June 2024
Website : https://journalofintegratedresearch.com/

Table 1 : Effect of integrated plant nutrient supply on grain yield, stover yield and total biological yield of maize crop.

Treatments	Grain yield (q/ha)			Stover yield (q/ha)			Total biological yield (q/ha)		
	2004	2005	Average	2004	2005	Average	2004	2005	Average
T_1	34.84	38.54	36.69	41.97	46.48	44.23	76.81	85.02	80.92
T_2	38.76	40.30	39.53	46.46	48.31	47.39	85.22	88.61	86.92
T_3	51.74	53.38	52.56	60.10	61.42	60.76	111.84	114.80	113.32
T_4	44.84	43.24	44.04	53.46	52.03	52.75	98.30	95.27	96.79
T_5	32.23	38.39	35.31	38.79	46.16	42.48	71.02	84.55	77.79
T_6	35.19	39.55	37.37	42.43	47.15	44.79	77.62	86.70	82.16
T_7	39.06	41.21	40.14	46.33	48.42	47.38	85.39	89.63	87.51
T_8	45.15	45.22	45.19	49.60	52.63	51.12	94.75	97.85	96.30
T_9	31.14	35.11	33.13	37.75	42.88	40.32	68.89	77.99	73.44
S.Em.±	1.97	1.98	1.18	1.56	1.94	1.28	3.83	3.81	2.42
CD (0.05)	5.91	5.94	3.86	4.68	5.82	4.20	11.49	11.43	7.90

T_1: Recommended dose of NPK (120: 60:40), **T_2** : Fertilizer dose based on soil test value, **T_3** : 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers, **T_4** : Azotobacter + 75% N and full dose of P & K through chemical fertilizers, **T_5** : Rhizobium + 50% P and full dose of N & K through chemical fertilizers, **T_6** : PSB (Phosphorus solubilizing bacteria) + 75% P and full dose of N & K through chemical fertilizers, **T_7** : *Azotobacter* + *Rhizobium* + PSB + 75% N, 25% P and 100% K through chemical fertilizers, **T_8** : *Azotobacter* + *Rhizobium* + PSB + 10 t ha^{-1} FYM and 33% N, no P and K through chemical fertilizers, **T_9** : 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK.

(Vermicompost + Chemical fertilizer). T_3 registered 58.6 per cent higher yield over T_9 in average data of both the years. In general, mean grain yield of maize increased with increasing substitution of NPK nutrients by FYM, bio-fertilizers such as *Azotobacter*, *Rhizobium* and PSB over chemical fertilizer alone. In support of this **Mustafa *et.al.* (2008)** found that the 100% recommended dose of N and P + Rhizobium + PSB has resulted in higher growth, yield attributes and yield of chickpea. Substantial increase in grain yield of maize due to application of FYM was also advocated by **Cremenescu *et al.* (1989)**. Combined use of *Azotobacter* + *Rhizobium* + PSB + FYM + Chem. (T_8) improved the crop yield markedly. This was primarily attributed to production of cytokinin in the *Rhizobium* by *Azotobacter*. Plant cytokinins are produced primarily in the roots and translocated via xylem to the shoots, which used to stimulate cell division and thus increase the yields **(Alagawadi and Gaur, 1988). Rudesh *et al*. (2005)** suggested that combined inoculation of rhizobium, PSB and *Trichoderma* spp.

Data given in Table 1 revealed that strover yield was highest in T_3 (FYM + chemical fertilizer) which was recorded significantly superior over rest of the treatments during both the years. Whereas, T_9 produced the least strover yield (37.75 q ha^{-1} in 1^{st} year and 42.80 q ha^{-1} in 2^{nd} year). **Singh *et.al.* (2006)** supported and reported that on application of Rhizobium and VAM resulted in the highest number of pods/plant (25.2)), seed yield per plant (6.9 g), test weight (151.7 g), seed yield (15.7), straw yield (5.56) and protein content (22.0%) in Chickpea.

Biological yield differenced significantly due to various treatments during both the years of study as well as in average values. It was recorded that biological yield was highest in T_3 (111.84 q ha^{-1} in 1^{st} year and 114.80 q ha^{-1} in 2^{nd} year) resulted in significantly higher than rest of the treatments during both the years and in average values also. While the minimum yield was obtained through application of 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK.(T_9) in both the years of investigation (68.89 ha^{-1} in 1^{st} year and 77.99 ha^{-1} in 2^{nd} year). In general, mean grain yield, strover yield, biological yield of maize increased with increasing substitution of NPK nutrient by FYM and bio-fertilizers such as *Azotobacter, Rhizobium* and PSB. showed increased NPKS uptake, plant height, number of branches, yield and total biomass in chickpea over un-inoculated control.

Content and Uptake

Nitrogen

Differences in nitrogen content in maize grain and stover as well as its uptake due to IPNS treatments were found significant during both the years and in average values. Integrated use of Azoto + Rhizobium + PSB + FYM + Chemical fertilizer (T_8) and Azoto + Chemical fertilizer (T_4) recorded statistically similar N content in grain and stover of maize during both the years and in their average values also. These treatments showed significant superiority to other remaining treatments. While the minimum values of N content was found with T_9 (Vermicompost + Chemical fertilizer 1.29% in grain and 0.68% in stover in 2004 and 1.30% grain and 0.68% in stover in 2005).

As regards to N uptake in grains and stover, T_3 showed significantly higher N uptake (77.61 kg ha^{-1} in grain and 58.30 kg ha^{-1} in stover in 2004 and 81.14 kg ha^{-1} in grain and 60.19 kg ha^{-1} in stover in 2005) than rest of the treatments in both the years of experimentation and in their average values also. The minimum average value (grain 42.91 kg ha^{-1} and stover 27.41 kg ha^{-1}) of N uptake was obtained in T_9 treatment.

Phosphorus

Phosphorus content in both grain and stover obtained from T_3 treated plot values 0.45 per cent and T_3 and T_8 treated plot value 0.705 per cent, respectively in average were found significantly higher over remaining treatments. Similar trend was also observed with uptake in both grain and stover of maize during both the years and it there average values also. As regards to P uptake in grains and stover, T_3 showed significantly higher P uptake (22.77 kg ha^{-1} grain and 42.67 kg ha^{-1} in stover in 2004 and 24.55 and 42.99 kg ha^{-1} in 2005).

Potassium

Variations in potassium content and uptake in maize grain and stover due to various IPNS treatments were found significant higher values of 0.59% and 1.80% potassium in grain and stover,

respectively on the basis of average data were associated with T_3 (FYM + Chemical fertilizer). However, markedly higher K uptake in stover was associated with T_3 (table-2). The minimum value was obtained under T_9 (60.88 kg ha^{-1} in average values).

Table 2: Nitrogen, Phosphorus and Potassium content and uptake (average of two years) by grain and stover of maize as influenced by integrated plant nutrient supply

Treatments	Content (%)						uptake (kg ha^{-1})					
	Nitrogen		Phosphorus		Potassium		Nitrogen		Phosphorus		Potassium	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
T_1	1.32	0.75	0.35	0.405	0.54	1.55	48.26	32.94	13.40	17.92	19.81	68.55
T_2	1.39	0.77	0.39	0.405	0.57	1.57	54.95	36.25	15.61	19.19	22.34	74.39
T_3	1.51	0.98	0.45	0.705	0.59	1.80	79.37	59.24	23.66	42.83	30.74	109.3
T_4	1.41	0.85	0.36	0.570	0.53	1.74	61.87	44.83	16.08	30.06	23.37	91.78
T_5	1.33	0.71	0.30	0.500	0.51	1.54	46.96	30.19	11.78	21.24	18.04	65.41
T_6	1.34	0.73	0.32	0.505	0.54	1.58	50.08	32.48	11.96	22.61	20.03	70.77
T_7	1.38	0.84	0.38	0.605	0.55	1.60	55.20	39.56	15.46	28.67	22.07	75.80
T_8	1.44	0.89	0.41	0.705	0.58	1.77	64.84	45.49	18.75	36.04	25.98	90.47
T_9	1.30	0.68	0.31	0.510	0.50	1.51	42.91	27.41	10.44	20.59	16.56	60.88
S.Em.±	0.005	0.0048	0.006	0.00081	0.012	0.0003	1.94	0.51	0.18	0.77	0.34	0.95
CD (0.05)	0.018	0.015	0.019	0.0026	0.042	0.0012	6.34	1.67	0.54	2.28	1.07	3.93

T_1: Recommended dose of NPK (120: 60:40), **T_2** : Fertilizer dose based on soil test value, **T_3** : 10 tonnes ha^{-1} FYM + Rest through chemical fertilizers, **T_4** : Azotobacter + 75% N and full dose of P & K through chemical fertilizers, **T_5** : Rhizobium + 50% P and full dose of N & K through chemical fertilizers, **T_6** : PSB (Phosphorus solubilizing bacteria) + 75% P and full dose of N & K through chemical fertilizers, **T_7** : *Azotobacter* + *Rhizobium* + PSB + 75% N, 25% P and 100% K through chemical fertilizers, **T_8** : *Azotobacter* + *Rhizobium* + PSB + 10 t ha^{-1} FYM and 33% N, no P and K through chemical fertilizers, **T_9** : 2 t ha^{-1} Vermicompost + 75% Recommended dose of NPK.

N, P and K content as well as their uptake by maize were maximum under integrated use of FYM + Chem. fertilizer (T_3) which was *at par* with treatment T_8 (*Azoto* + *Rhizobium* + PSB + FYM + Chem.) and T_4 (*Azoto* + *Chem.*). These treatments showed significant superiority over the other remaining treatments. This might be due to increased supply of nutrients directly through organic (FYM, PSB, *Azotobacter* & *Rhizobium*) and inorganic sources to the crop as well as indirectly through checking the loss of nutrients (N, P and K) from soil solution which is turn resulted in better growth (Table 2), higher biological yield as well as more nutrient concentration in treatment T_3 (Table 2). Increased uptake of N, P and K by maize is due to *Azotobacter* inoculation **(Sikilar, 1974)**, application of FYM (Meshram and Shinde, 1982); PSB (Alagawadia and Gaur, 1988; Jisha and Alagawadia, 1996; Patil, 1997) and *Rhizobium* (Sreenivasa, 1992, and Prathiba, 1994) have also been reported earlier.

REFERENCES

- Alagawadi, A.R. and Gaur, A.C. 1988. Associative effect of rhizobium and phosphate solubilizing bacteria on the yield and nutrient uptake of chickpea. *Plant and Soil Res.,* 105: 241-246
- Cremenescu, G.; Ceausu, C., Povarna, F., lancu, D., Mihailescu, D.; Marinescu, M. and Popescu, C. 1989. Analele Institutului-decercetari Pentru Cereals-si-Plante-Technice, Fundulea. 53: 153-171.
- Jackson, M.L. 1958. Soil chemical analysis. Prentice Hall, Inc. Engle Wood Cliffs, N.J.U.S.A.
- Jisha, M.S. and Alagawadi, A.R. 1996. Nutrient uptake and yield of sorghum inoculated with phosphate solubilizing bacteria and celluloytic fungus in a cotton amended vertisol. *Microbiol Res.,* 151 : 1-5.
- Meshram, S.U. and Shende, S.T. 1982. Total nitrogen uptake by maize with *azotobacter* inoculation. *Plant and Soil Res.,* 62 (2): 275-279.
- Mustafa, M.N. Sagar, G.Kaurana, Chandrika, V. and Reddy, P. M. 2008. Growth and yield of chickpea as influenced by irrigation and nutrient management. *Legume research*, 31(3): 221-223.

- Patil, C.B. 1997. Effect of varying fertility levels on productivity of cropping systems under irrigation in semi and regions of India. *Indian J. of Agronomy*, 42: 2, 210-213.
- Prathiba, C.K.; Alagawadi, A.R.; Sreenivasa, M.N.; Khadi, B.M.; Janagoudar, B.S. and Patil, T.C. 1994. *Rhizosphere* microflora influenced cotton by combined inoculation of *Azospirillum* and *Pecudomonas striata* or *Glumus fasciculatum. J. Soil Bio. Ecol.*, 14: 11-16.
- Rudesh, O.L. ; Shivprakash, N.K. and Prasad, R.O. 2005. Effect of combined application of Rhizobium, PSB and *Trichoderma species* on growth, nutrient uptake and yield of chickpea. *Applied Soil Ecology*, 28 (2) : 139-146.
- Shivay, Y.S.; Singh, R.P.; Pal, M. and Pal, M. 2001. Productivity and economics of maize as influenced by intercropping with legumes and nitrogen level. *Ann. Agric. Res.*, 22(4) : 576-582.
- Sikilar, A.G.H. 1974. Effect of Single Vs. multiple Stain inoculum of Azotobacter on yield, nitrogen phosphorus uptake in maize (*Zea Mays. Linn.*) thesis M.Sc. (Ag.). Mahatma Phule Krishi Vidyapeeth, Rahur.
- Singh, G. and Singh, O.P. 1993. Intercropping compatibility of different crops with winter maize. *Indian J. Agron.*, 38(4) : 519-522.
- Singh, R.N. ; Shukla, D.N. and Nirmal, D.C. 2006. Effect of biofertilizer fertility level in weed management on weed growth and yield of late sown chickpea. *Indian Journal of Agricultural Sciences*, 76 (9) : 561-563.
- Snedecor, G.M. and Cocran, W.G. 1968. Statistical methods. Sixth. Edn. Oxford and IBH Publising Co. Colkata.
- Sreenivasa, M.N., 1992. Selection of an efficient Vasicular arbuscular my corrhizal fungus for chilli (*Capsicum annuum* L). *Scientia Horticulture*, 50: 53-58.