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RESPONSE OF NITROGEN IN WINTER MAIZE (*ZEA MAYS* L.) IN CENTRAL PLAIN AGRO CLIMATIC ZONE OF U.P., INDIA

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Abstract

A field study entitled "Nitrogen management in rabi grown baby corn (*Zea mays* L.) in central plain climatic zone of U.P." was carried out during 2008-09 at Student's Instructional Farm, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.), India. Treatments comprised 12 combinations of 3 nitrogen levels (50, 100, 150 kg N/ha) and 4 timings of N application *viz*. ½ basal + ½ KHS, 1/3 basal + 2/3 KHS, ½ basal + ¼ KHS + ¼ pre-tasseling stage and 1/3 basal + 1/3 KHS + 1/3 PTS, plus one absolute control without nitrogen. Thus, 13 treatments were tested in randomized block design with 3 replications. Experimental soil was sandy loam, slightly alkaline in nature and of medium fertility status. A uniform dose of 60 kg P_2O_5 + 40 kg K_2O/ha was applied to all treatments.

The results obtained revealed that the level of 150 kg Nha^{-1} attained highest values of dry matter plant^{-1} at harvest (173.90 g), plant height (145.24 cm), without husk cob weight (13.22 g), cob length (8.65 cm), cob girth (2.90 cm), cob diameter (1.18 cm), cobs/plant (1.46), cob yield (1682 kgha^{-1}), green fodder yield (33803 kg ha^{-1}) and net return (Rs. 67382 ha^{-1}) with 3.67 B:C ratio. Among timings, N application in 3 equal splits each at basal, KHS and PTS registered highest values of dry weight/plant (168.45 g), plant height (136.08 cm), without husk cob weight (11.47 g), cob length (8.16 cm), cob girth (2.82 cm), cob diameter (1.15 cm), cobs plant^{-1} (1.42), cob yield (1534.33 kg ha^{-1}), green fodder yield (33730 kg ha^{-1}) and net return (Rs. 61954 ha^{-1}) with 3.49 B:C ratio.

The interaction between levels and times of N application was not found significant in any case except net return. However, 150 kg N ha^{-1} applied in 3 equal splits produced highest fresh cob yield (1807 kg ha^{-1}), green fodder yield (38260 kg ha^{-1}) and earned maximum net return (Rs. 75675 ha^{-1}) with highest B:C ratio (3.99) from the crop of rabi baby corn.

Key words : Nitrogen, cultivation, plant, population, pre tasselling stage, knee high stage.

Introduction

Baby corn is the ear of corn plant and young, fresh finger like green ear harvested before or just at the time of silk emergence for use. It is recognized as a chemical free vegetable product. Unfertilized young ears are harvested and consumed in salad and for stir dried dishes. Its acceptance in restaurants and homes all over the world has increased the demand dramatically in countries like Thailand, which is one of the major exporters of the baby corn. It was get an export industry with a value exceeding $40 million per year. Export of canned baby corn is by the largest market ($ 36 million) followed by fresh baby corn ($ 4 million) (Cenceros and Singh, 2001). The cultivation of baby corn is a recent development in India, where farmers of Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Karnataka and Andhra Pradesh have started the cultivation of baby corn as most profitable enterprise. A monetary income from grain maize crop is normally obtained Rs. 12-15 thousand/ha, which is quite low in comparison to net monetary income being realized about Rs. 40-50 thousand from a single crop of baby corn. Usually 2-4 crops can be taken in single agricultural year depending upon irrigation facilities. Nitrogen is the essential constituent of protein, nucleic acid, nucleotide, amino acid, chlorophyll, phospholipids, alkaloids, enzymes, hormones. Vitamins etc. imparts dark green colour to plant, improves quality and succulence of baby corn and other fodder crop. Deficiency of nitrogen provokes provides the synthesis of anthocynin which gives different types of colouration. Time of N application also plays an

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important role in baby corn. Nitrogen application in 3 equal split doses as first at based second at Knee high stage and third at pre-tasseling stage resulted in significantly higher growth yield attributes, marketable baby corn, yield green fodder yield with lowest discarded baby corn, maximizing net return and benefit : cost ratio. The apparent nitrogen recovery was highest at 150 kg N/ha whereas physiological and agronomic efficiency progressively decreased with increasing nitrogen levels. The nitrogen application in 3 equal split doses in maize resulted in the highest nitrogen recovery and agronomic use efficiency. It has been generally recommended that one third nitrogen and total quantity of phosphorus and potassium should be applied before sowing. The rest of nitrogen may be applied in 2 equal doses at the knee high stage and pre-tasseling stage of maize to increase the growth and yield of maize.

Considering the above facts, the present study entitled "Nitrogen management in rabi grown baby corn (*Zea mays* L.) grown in rabi season" was under taken with following objectives:

1. To study the effect of nitrogen levels on growth and yield attributes as well as yield of baby corn.
2. To optimize the suitable time of nitrogen application for achieving maximum yield potential of crop.
3. To work out the economics of different treatments.

Materials and Methods

A field experiment was conducted during *Rabi* season of 2008-09 of Student Instructional Farm, Department of Agronomy, C. S. Azad University of Agriculture & Technology, Kanpur (U.P.), India. It is situated at in the alluvial tract of Gangetic plain in central part of U.P. between 250 26' to 260 58' north latitude and 79031' to 800 34' east longitude at alleviation of 125.9 meter from the sea level. The mean annual rainfall of Kanpur is 890 mm/annum and more than 80% generally occur during the monsoon season (June to September). The winter months are cooler with occasional frost during last week of December to mid January. The soil are experimental field was sandy loam in texture and slightly alkaline in reaction with pH 7.6 (1:2.5, soil : water), EC 0.29 dsm^{-1} having medium organic carbon (5.50 g kg^{-1}) and available nitrogen (116.8 kg ha^{-1}) and medium in available phosphorus (18.8 kg ha^{-1}) and potassium (130 kg ha^{-1}) at 0-15 cm soil depth. The experiment was laid out in R.B.D. (Randomized block design) keeping 4 level of nitrogen (0, 50, 100 & 150 kg ha^{-1}) in 13 treatment with 3 replications.

The experiment field was prepared after pre sowing irrigation at proper moisture conditions. First ploughing was done by turning plough followed by to crass harrowing and planting was done after each ploughing to make the field level and to conserve the moisture for better germination of the seed. The winter maize variety "sharadmani" was sown in rows spacing 45 cm. apart. The recommended seed rate (30 kg ha^{-1}), winter maize was used in the experiment. The recommended doses of phosphorus (60 kg ha^{-1}) and potassium (40 kg ha^{-1}) through S.S.P. and M.O.P. at the time of sowing. The nitrogen was given as per treatments half dose nitrogen and full dose of phosphorus and potassium were applied as basal and remaining half dose of nitrogen was applied in two equal split *i.e.* at knee high stage and pre tasseling stage of the crop. The other agronomical cultural practices such as irrigation, thinning, weeding and detasseling operation have been performed as per requisite.

The growth attributes *viz*. plant height, dry weight of plant at knee high stage, plant population per plant and dry weight of plant at harvest stage and yield attributing characters *viz*. length of baby corn, girth of baby corn, no. of baby corn per plant, weight of baby corn, dehusked baby corn yield and green fodder yield were measured from five randomly selected tagged plants per plot. The net plot area was harvested and yield were recorded and calculate the cast of baby corn cultivation of individual treatment, common cost of cultivation was calculated first and treatment cost was added there after to calculate the total cost of cultivation under different treatment. The grass income was calculated by multiplying the cob and green fodder yield of each treatment with their prevailing market prices. Net monitory return was worked out by subtracting treatment wise total cost of cultivation from their grass monitory return. The benefit : cost ratio was computed by the following formula :

$$B:C = \frac{\text{Total realization}\left(\text{Rs.ha}^{-1}\right)}{\text{Total expenditure}\left(\text{Rs.ha}^{-1}\right)}$$

Results and Discussion

Effect of different levels and nitrogen timings treatment on growth of baby corn

Maintenance of optimum plant stand/unit area is of paramount importance in crop production. In presented study, plant stand of baby corn was not influenced significantly by treatment effects (table 1). It might be due to the reason that nitrogen levels and timings had no effect on establishment or survival of corn plants. Dry weight/plant increased with increasing N levels upto

Table 1 : Effect of levels and timing of nitrogen application on growth attributing characters of baby corn.

Nitrogen levels (kg ha^{-1})	Plant stand (000 ha^{-1})		Plant height (cm)	Dry weight/plant (g)	
	Initial	Final		At KHS	At harvest
Control	114.81	111.68	72.85	23.55	102.10
50	112.96	110.91	114.23	43.40	142.68
100	115.69	111.98	133.56	49.10	161.51
150	111.37	109.20	145.24	54.62	173.90
S.Ed.±	1.89	1.51	2.53	1.06	3.89
C.D. (P=0.05)	NS	NS	5.23	2.19	8.03
Timing of nitrogen application					
½ basal + ½ KHS	113.75	111.06	125.12	46.36	147.68
1/3 basal + 2/3 KHS	112.31	109.82	129.55	48.38	158.53
½ basal + ¼ KHS + ¼ PTS	112.51	109.82	133.29	49.75	162.80
1/3 basal + 1/3 KHS + 1/3 PTS	114.78	112.09	136.08	51.67	168.45
S. Ed. ±	2.18	1.74	2.93	1.23	4.49
C.D. (P=0.05)	NS	NS	6.04	2.53	9.28

Table 2 : Effect of levels and timing of nitrogen application on yield attributing characters of baby corn.

Nitrogen levels (kg ha^{-1})	Cob weight $plant^{-1}$ (gm)		Cob length $plant^{-1}$ (cm)		Cob girth $plant^{-1}$ (cm)		Number of baby corn	Marketable cob yield (kg ha^{-1})	Green fodder yield (kg ha^{-1})
	With husk	Without husk	With husk	Without husk	With husk	Without husk			
Control	19.30	3.67	12.33	4.15	3.10	2.01	1.13	838.00	16235
50	34.10	7.32	17.34	6.65	4.28	2.43	1.27	1124.25	24867
100	46.23	10.25	19.03	7.68	4.56	2.70	1.36	1412.75	29373
150	58.12	13.22	20.58	8.65	4.86	2.90	1.46	1682.00	33803
S. Ed. ±	0.72	0.36	0.36	0.11	0.05	0.05	0.01	34.35	650
C.D. (P=0.05)	1.49	0.73	0.75	0.23	0.11	0.10	0.03	70.89	1342
Timing of Nitrogen application									
½ basal + ½ KHS	40.89	9.06	18.23	7.14	4.40	2.52	1.31	1310.67	25649
1/3 basal + 2/3 KHS	44.05	9.77	18.76	7.48	4.51	2.63	1.34	1372.33	28027
½ basal + ¼ KHS + ¼ PTS	48.31	10.75	19.24	7.85	4.63	2.74	1.38	1408.00	29984
1/3 basal + 1/3 KHS + 1/3 PTS	51.35	11.47	19.70	8.16	4.74	2.82	1.42	1534.33	33730
S. Ed. ±	0.83	0.41	0.42	0.13	0.06	0.06	0.02	39.66	751
C.D. (P=0.05)	1.72	8.85	0.87	0.27	0.12	0.12	0.03	81.85	1549

highest level of 150 kg N/ha at both stages of observation (table 1). It could be attributed to the favourable effect of increased N on cell enlargement in production of larger leaves and improving photosynthetic efficiency of plants. Thus, production of more photosynthates at higher level of N application might has increased the dry matter production of corn plants. Among timings, N application in 3 splits showed higher dry weight $plant^{-1}$ than in 2 splits. Regular availability of N in soil for plant use increased its uptake which improved plant growth resulted in higher dry matter accumulation/plant.

Plant height also increased with N levels and maximized at 150 kg N ha^{-1} (table 1). Nitrogen is an integral part of chlorophyll, which is the primary absorber

Table 3 : Effect of levels and timing of nitrogen application on economics of baby corn.

Nitrogen levels (kg ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
Control	23300	45696	22396	1.96
50	24075	63620	39545	2.64
100	24650	78540	53890	3.18
150	25250	92632	67382	3.67
S. Ed. ±		1033	711	0.07
C.D. (P = 0.05)		2132	1468	0.15
Timing of Nitrogen application				
½ basal + ½ KHS	24600	71663	47063	2.90
1/3 basal + 2/3 KHS	24600	75914	51314	3.08
½ basal + ¼ KHS + ¼ PTS	24717	78808	54091	3.18
1/3 basal + 1/3 KHS + 1/3 PTS	24717	86671	61954	3.49
S. Ed. ±		1193	821	0.09
C.D (P = 0.05)		2462	1695	0.18

of high energy needed for photosynthesis. Increased availability of N at higher rates of application might has promoted leaf, stem and other vegetative growth through cells enlargement which resulted in higher plant height of corn plants at increased levels of N application. Application of N in 3 splits maintained higher plant height than in 2 splits. It might be associated with higher uptake of N due to regular availability of N in soil.

Effect of different levels and nitrogen timings treatment on yield attributes of baby corn

Cob size in the forms of length, girth, diameter and weight, was recorded remarkably higher with husk compared to without husk (table 2). It might be due to more accumulation of photosynthates in husk because early harvest of crop gave no chance of photosynthates translocation from vegetative to reproductive organs. Baby corn is harvested just after vegetative growth is ceased and before reproductive growth takes place. At initiation of cob formation, husk is formed from different layers of over lapping well developed sheath leaves due to which cob size with husk is much higher than without husk. Length, girth and diameter of cob increased significantly with levels of nitrogen upto 150 kg ha^{-1}, where maximum values were recorded. It might be due to higher uptake of N in crop plants at higher level of application. Higher uptake increased the N concentration in plant which is necessary for maximum growth. Therefore, length, girth and diameter of cob were recorded higher at increased levels of N application. Increase in cob size of baby corn due to increased levels of nitrogen. Among timings, N application in 3 splits attained higher values of cob length, girth and diameter than in 2 splits. It might be attributed to availability of N for crop plants as maximum uptake of N in corn takes place before a week of tasseling till silking. Thus, cob size increased at N application in 3 splits compared to 2 splits application. Weight per cob also increased with N application upto 150 kg N ha^{-1} and in 3 equal splits (table 2). It may be attributed to length, girth and diameter of cobs which also increased upto same level of N application. Number of cobs plant^{-1} showed significant increase upto highest level of 150 kg N ha^{-1} (table 2). It might be due to higher uptake of N in plants which increased N concentration in plants thereby improved corn growth in form of cobs formation. In case of timings, N application in 3 equal splits produced significantly maximum number of cobs/plant. These also may be associated with supply of N at the time of plant requirement for maximum growth.

Effect of different levels and nitrogen timings treatment on yield of baby corn

Fresh baby corn yield increased with increasing N levels significantly upto highest level of 150 kg N ha^{-1} (table 2). Fresh cob yield at 150 kg N ha^{-1} was produced 19.1, 49.6 and 100.7% higher than lower levels of 100, 50 and zero kg N ha^{-1}, respectively. Such higher fresh cob yield of baby corn are attributed to various yield attributes like cob size (length, girth, diameter), cob weight and number of cobs plant^{-1}, which also behaved in similar manner to nitrogen levels. As the baby corn crop being harvested in very early stage of silk emergence, response to nitrogen appears linear and hence 150 kg N ha^{-1} performed best in baby corn production. Increase in baby corn yield with increasing N application upto higher levels. Among timings, N application in 3 equal splits recorded significantly highest baby corn yield. It was attributed to different yield attributes, which also maximized with N application in 3 equal splits. The reason may be explained that regular availability of N as per crop need resulted in higher N uptake which increased its concentration in plants thereby higher yield under N application in 3 equal splits.

Effect of different levels and nitrogen timings treatment on green fodder yield

Green fodder yield of baby corn increased with N levels and significantly maximized at 150 N ha^{-1} (table 2). It was attributed to dry weight plant-1 and plant height which also recorded highest at same level of N application. The crop of baby corn is harvested just at plant growth is ceased, thus translocation of nutrients and photosynthates could not take place from vegetative parts to reproductive organs which increased the green fodder yield. Higher doses of N applied to corn increased its availability and uptake, resulting in production of more photosynthates in terms of dry matter, which ultimately increased the green fodder yield at higher application of nitrogen. Among timings, N application in 3 equal splits produced significantly highest green fodder yield (table 2). It was attributed to dry weight $plant^{-1}$ and plant height, which also maximized at 150 kg ha^{-1}. Regular availability of N ensured higher uptake of N as per crop need which resulted in more formation of photosynthates thereby higher fodder yield.

Economics of treatments

Cost of cultivation was higher at increased levels of N (table 3) and it was due to increased cost of N fertilizer. N application in 3 splits required slightly higher cost because of extra labour involved in top dressing of fertilizer. Gross return was obtained significantly highest at 150 kg N ha^{-1} (table 3). It was attributed to higher cob yield and green fodder yield at same level of N application. Similarly highest gross return under 3 equal split application of N was attributed to higher yield of cob and green fodder. Net return was also registered maximum at 150 kg N ha^{-1} (table 3). It might be attributed to highest gross return at same level of nitrogen application. Though, cost of cultivation was also highest at 150 kg N ha^{-1}, but increased gross return was so much that it could not only compensated the cost but increased net return to the maximum. Application of N in 3 equal splits recorded maximum net return values, which might be associated with highest gross return values. As increase in cost was much lesser than the return, net return was maximum under this treatment of N timing of application. Benefit: cost ratio followed the same pattern of gross income under different treatments. Increase in gross return, net return and/or B:C ratio due to N application at increased rates and in 3 splits application in baby corn cultivation.

Conclusion

The results of present study could be concluded in the light of set objectives here as below:

(i) Increasing levels of nitrogen increased growth, yield attributes and yield of baby corn significantly upto 150 kg N ha^{-1}, where highest of 1682 kg ha^{-1} fresh cob yield of baby corn was produced.

(ii) Among timings of N applications, 1/3 at basal + 1/3 at knee high stage (KHS) + 1/3 at pre-tasseling stage (PTS) retained highest values of growth and yield attributes and produced significantly maximum fresh cob yield (1534.33 kg ha^{-1}) of baby corn.

(iii) Gross return, net return and B:C ratio were computed highest at 150 kg N ha^{-1} and with application in three equal splits.

References

Cenceros Gonzalez, F. and M. N. Singh (2001). Maize-an optional crop for nutrition and profitability. *Indian Farming*, Class 200 pp. 29-32.

Olsen, S. R., C. W. Cale, F. S. Watanable and I. A. Den (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. Circular United State Department of Agriculture (Washington) : 19.

Prasad, U. K., H. C. Thakur, S. S. Pandey, R. D. Pandey and N. N. Sharma (1987). Effect of irrigation and nitrogen on winter maize in calcareous saline alkali soil. *Indian Journal of Agronomy*, **32 (3)** : 217-2.

Kumar, K. A., G. K. Sagar, G. P. Reddy and P. M. Reddy (2008). Effect of integrated nitrogen management on growth, yield and quality of baby corn.*Crop Research* (Hisar), **36 (1-3)** : 60-62.20.

Muthukumar, K. B., K. Velayudham and N. Thavaprakash (2007). Influence of plant growth regulation and times of nitrogen application on nutrient uptake and green cob yield of baby corn (*Zea mays* L.). *Journal of Ecobiology*, **20 (4)** : 355-360.

Thakur, D. R. and V. Sharma (1999). Effect of varying rates of nitrogen ad its schedule of split application in baby corn (*Zea mays* L.). *Indian Journal of Agricultural Sciences*, **69 (2)** : 93-95.