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INTEGRATED NUTRIENT MANAGEMENT IN WINTER MAIZE UNDER TERAI CONDITION OF NEPAL

Pramod Prasad Dahal[1], Komal Bahadur Basnet[2], Shrawan Kumar Sah[3] and Tika Bahadur Karki[4]
Agriculture and Forestry University, Rampur, Chitwan
[1]*Post Graduate, Agriculture and Forestry University, Rampur, Chitwan,Nepal*
dpramodprasad@gmail.com
[2]*Prof. Agronomy, Agriculture and Forestry University, Rampur, Chitwan*
[3]*Prof, Agronomy, Agriculture and Forestry University, Rampur, Chitwan,*
profshrawan@gmail.com
[4]*Senior scientist, Nepal Agricultural Research Council, Singhdurbar Plaza, Kathmandu,*
tbkarki2003@gmail.com

ABSTRACT

A field experiment on "Integrated Nutrient Management in winter maize under terai condition of Nepal" was accomplished at research farm of National Maize Research Program (NMRP), Rampur, Chitwan, Nepal during winter season of 2015/16. The experiment was laid out in split-split plot design with three replications consisting of two FYM levels as main plots (FYM @ 10 t ha-1 and no FYM application), three nitrogen levels as sub plots (100, 75 and 50% N of recommended dose P and K remaining constant) and two levels of seed inoculation (Azotobacter chrococcum seed inoculation and no inoculation) as sub-sub plots to find out the effect of Farm Yard Manure (FYM), different Nitrogen Levels and Biofertilizer (Azotobacter chroococcum) on growth and development of winter season hybrid maize (Rampur Hybrid-2) in Chitwan, Nepal. Thus, application of FYM @ 10 t ha-1 produced insignificantly higher grain yield (4.58 t ha-1) in comparison to without its application (3.91 t ha-1). Moreover, an increase in nitrogen level from 50 to 100% of recommended dose (120 kg N ha-1) increased grain yield significantly (2.95, 4.64 and 5.16 t ha-1, at 50, 75 and 100 % N of recommended dose, respectively). Besides this, significantly higher grain yield was also obtained by Azotobacter chroococcum seed inoculation (4.55 t ha-1) as compared to no inoculation (3.95 t ha-1). Further, the net return obtained from the application of FYM @10 t ha-1 (NRs 61, 161 ha-1) was remarkably higher than without it (NRs 54, 4479 ha-1). On the other hand, significantly higher net return was obtained with 100 (NRs 79, 704 ha-1) than 75 (NRs 67,539 ha-1) and 50 % (26, 217 ha-1) N of recommended dose which also differed significantly. Similarly, the net benefit obtained with azotobacter seed inoculation (Rs 65, 084 ha-1) was also significantly higher in comparison to no inoculation (Rs 50, 555 ha-1). Thus, it can be mentioned that for winter season hybrid maize (Rampur Hybrid-2), application of recommended dose of nitrogen (120 kg ha-1) and azotobacter seed inoculation are essential to achieve higher grain yield and net return at Rampur, Chitwan, Nepal.

KEY WORDS: Integrated Plant Nutrient Management, winter maize, FYM, nitrogen levels, biofertilizers

1. INTRODUCTION

Recent studies conclusively proved that maize is a potential winter season crop having three times higher yield potential than kharif crop (Desai, Singh & Deore, 1980; Nayak, Chatterjee & Das, 1987). According to the annual report of NMRP (2015), Rampur, Chitwan, the productivity of winter maize is about 6-7 t/ha while that of summer maize is 5.0 t/ha. Therefore, it is essential to give emphasis on improvement of grain yield of winter maize in order to fulfill the demand of the country in maize grains. Further, the hybrid maize is a heavy feeder and more responsive to nutrients and the required amount of nutrients may be supplied through organic manures and inorganic fertilizers to grow it and to maintain soil fertility in a sustained manner (Sarkar, Singh & Singh, 2000). For increasing the profitability of maize in only economic view, farmers are cultivating the crop intensively with the huge use of chemical fertilizers, pesticides, weedicides, etc (Kalhapure, Shete & Dhonde, 2013) which renders the arable soils unproductive as a consequence of unfavorable physical, chemical and biological characteristics of soil

(Kumar, Singh, Rao & Singh, 2008). Hence, the integrated use of inorganic fertilizers with organic, including biofertilizer, can greatly increase the efficiency of applied nutrients without causing any ill effects on the soil health and therefore appears to be an ideal way for sustained crop production and pollution free environment (Mahajan and Gupta., 2007; Ram, 2000). Further, biofertilizers are gaining importance as they are ecofriendly, non-hazardous and nontoxic products (Sharma, Agrawal, Bhatnagar & Sharma, 2007). In this context, integrated nutrient management (INM) can be an option which is a flexible approach to minimize the use of chemical sources of nutrients along with maximization of their efficiency and farmer`s profit.

2. MATERIALS AND METHODS

A field experiment was conducted during summer season (October to March) of 2015 at the research farm of National Maize Research Program (NMRP), Rampur, Chitwan, Nepal with Rampur Hybrid-2. The experimental soil was sandy loam in texture, having slightly acidic pH (5.4). Organic matter (4.02), total nitrogen (0.11), available phosphorus (58.0 kg ha-1), available potassium (253.8 kg ha-1). The experiment was laid out in strip-split plot design consisting of 12 treatments with three replications. FYM levels as main plots (FYM @ 10 t ha-1 and no FYM application), three nitrogen levels as sub plots (100, 75 and 50% N of recommended dose P and K remaining constant) and two levels of seed inoculation (Azotobacter chrococcum seed inoculation and no inoculation) as sub-sub plots. Farm Yard Manure(FYM) was applied two weeks before sowing and well mixed to soil.Chemical fertilizers: urea, single super phosphate (SSP), diammonium phosphate (DAP) and muriate of potash (MOP) were also applied as a main source of nitrogen, phosphorus, and potassium, respectively. Urea was applied in three splits; at sowing, knee heigh and tasseling stages. Azotobacter was applied as seed inoculation preparing of slurry of 10% sugar solution mixing 100 gm of sugar on 1000 ml of water and was boiled and azotobacter were applied after cooling on shade. Harvesting was done on March of 2014, from net plot area.

3. RESULTS AND DISCUSSION

3.1 Effect on yield attributes

The yield attributes (Table 1) were significantly higher with FYM @ 10 t ha^{-1} than without it, however, significant difference was obtained in thousand grain weight. Significant effect of FYM application @ 10 t ha^{-1} on 1000 grain weight of maize crop was also recorded by Dutta et al, (2014); Tetwarlal et al,(2011); Bunker et al (2012) and Singh et al, (2009) in comparison to control during kharif season of Uttarkhand, Rajasthan, Gujrat and Udaipur of India, respectively. Significant increment in thousand grain weight assisted to produce significantly higher grain yield in 100 than 75 and 50% N of the recommended dose (Table 2) through significantly higher weight of grains per cob and number of cobs harvested per hectare. The positive response of nitrogen application on yield attributes of maize could be ascribed to overall improvement in crop growth enabling the plants to absorb more nutrients which empower the plants to manufacture more quantity of photosynthates accumulating them in reproductive parts (Singh & Totawat, 2002). Significantly higher thousand grain weight was obtained with 100 (210 g) than 75% (201 g) N of recommended dose by Singh et al, 2009 during kharif season at Udaipur, India. Moreover, significantly higher number of grains per row was obtained with azotobacter inoculation than no inoculation which assisted to give significantly higher number of grains per cob owing to insignificantly higher number of grains rows per cob. This together with significantly higher thousand grain weight was able to give significantly higher grain yield in the treatment with azotobacter seed inoculation (4.55 t ha^{-1}) in comparison to no inoculation (3.95 t ha^{-1}). This might be due to an improvement in nutrition status of the soil and creation of congenial environment for better root growth through secretion of growth promoting substances (gibberellin, cytokinin and auxin) and availability of nitrogen fixed by microorganisms (Okon and Kapulinth, 1986; Shah and Joshi, 1986).

Table 1. Yield attributes of maize hybrid as influenced by integrated nutrient management at NMRP, Rampur, Chitwan, Nepal, 2015/16

Treatments	No of cobs per hectare (,000/ha)	No of grains rows per Cob	No of grains per Row	No of grains per cob	weight of cob with grains (g)	Weight of grains per cob (g)	TGW (g)	Shelling percent (%)
FYM levels								
0 t ha^{-1}	65966	12.73	19.16	244	79.90	62.70	225.5	78.15
10 t ha^{-1}	67540	12.99	19.48	252.90	87.30	69.10	256.5	78.77
F test	NS	NS	NS	NS	NS	NS	*	NS
LSD (=0.05)	5788.80	0.70	2.35	29.61	9.35	8.35	24.87	2.90
SEm (±)	1345.40	0.11	0.39	5.51	1.54	1.37	4.09	0.48
Nitrogen levels (% of recommended dose)								
50%	61552 [b]	12.49 [a]	18.30 [c]	228.40 [c]	63.96[c]	48.60[c]	197.9[c]	76.0[b]
75%	64842 [b]	12.83 [a]	19.39 [b]	248.50 [b]	85.31[b]	66.90[b]	252.4[b]	78.40[b]
100%	73865 [a]	13.26 [a]	20.26 [a]	268.50 [a]	101.57 [a]	82.20 [a]	272.7 [a]	80.97 [a]
F test	*	NS	*	**	*	*	**	*
LSD (=0.05)	4281.50	0.91	0.86	11.49	10.14	5.67	14.44	2.45
SEm (±)	1856.70	0.28	0.26	3.52	3.11	2.43	4.43	0.75
Biofertilizer								
No inoculation	65853	12.59	18.94	238.3	78.80	61.90	228.0	78.20
Azotobacter chroococcum	67653	13.13	19.70	258.7	88.40	69.90	253.9	78.71
F test	**	NS	**	**	**	**	**	**
LSD (=0.05)	2224.40	0.36	0.57	5.72	7.53	7.93	6.91	0.48
SEm (±)	1020.90	0.12	0.18	1.86	2.44	1.84	2.24	0.32
CV %	4.6	4	4.0	3.2	12.4	11.8	3.9	1.7
Grand mean	66753.0	12.86	19.32	248.5	83.6	65.9	241.0	78.46

Recommended dose of nitrogen : 120 kg N ha^{-1} Azotobacter inoculation at the rate of 40 gm kg^{-1} seed

4. Effect on grain yield, stover yield and harvest index

Grain yield (4.58 t ha^{-1}) obtained with the application of FYM @ 10 t ha^{-1} was insignificantly higher than no FYM (3.91 t ha^{-1}). Application of FYM with nitrogen increases the uptake of nutrients due to release of sufficient amount of nutrients by mineralization which in turn gives higher yield (Karki et al.,

2005). Tetwarlal et al., 2011, concluded that application of 10 t/ha FYM along with RDF is the right choice for increasing the grain yield of rainfed hybrid maize in Rajasthan. Increasing nitrogen rates significantly increased the grain yield. Sanjeev and and Bangarwa (1997) reported that grain yield increased with increasing nitrogen rates. An enhancement in photosynthesis due to more N application results in higher yield (Chouhan et al, 2015). Moreover, the azotobacter seed inoculation showed significant increment in grain yield. Thus, significantly higher grain yield was obtained with azotobacter seed inoculation (4.55 t ha^{-1}) in comparison to no inoculation (3.95 t ha^{-1}). The effect of azotobacter on yield may also be attributed to its multiple actions by fixing nitrogen and also by solubilization of soil phosphate and by providing metabolites that stimulate the plant development (Mehram and Shende, 1982).

Table 2. Grain yield (t ha^{-1}), stover yield (t ha^{-1}) and harvest index of maize hybrid as influenced by integrated nutrient management during winter season at NMRP, Rampur, Chitwan, Nepal, 2015/16

	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index, HI	Net returns (NRs. ha^{-1})	B:C ratio
FYM levels					
0 t ha^{-1}	3.91	5.98	0.39	54479	2.09
10 t ha^{-1}	4.58	6.01	0.43	61161	2.03
F test	NS	NS	NS	NS	NS
LSD (=0.05)	2.20	1.80	0.04	16889.8	0.42
SEm (±)	0.36	0.30	0.01	9349.4	0.17
Nitrogen levels (% of recommended dose)					
50%	2.95 [c]	4.79 [c]	0.38 [b]	26217[c]	1.50[b]
75%	4.64 [b]	6.01 [b]	0.43 [a]	67539[b]	2.24[a]
100%	5.16 [a]	7.18 [a]	0.42 [a]	79704[a]	2.42[a]
F test	**	**	**	**	**
LSD (=0.05)	0.41	0.94	0.03	10786.3	0.21
SEm (±)	0.12	0.29	0.01	3307.5	0.06
Biofertilizer					
No inoculation	3.95	5.99	0.39	50555	1.93
Azotobacter chroococcum	4.55	6.00	0.43	65084	2.18
F test	**	NS	*	**	*
LSD (=0.05)	0.40	0.45	0.03	9993.7	0.19
SEm (±)	0.13	0.144	0.01	3243.3	0.06
CV %	12.9	10.2	4.8	23.8	12.7

Grand mean	4.25	5.99	41.10	57820	2.05

Recommended dose of nitrogen : 120 kg N ha^{-1} Azotobacter inoculation at the rate of 40 gm kg^{-1} seed

Moreover, an increase in grain yield may be due to bacterization with azotobacter culture helping in fixation of atmospheric nitrogen, secretion of growth promoting substances resulting in better seed germination and expanded root system for nutrient uptake (Laxminarayana, 2001). Slightly higher stover yield was obtained with FYM (@ 10 t ha^{-1}) application than no FYM application. Increase in nitrogen level from 50 to 100 % N of recommend dose increased the stover yield significantly. The increased availability of nitrogen at increasing level might have improved the growth attributes which enhanced the photosynthesis and translocation of carbohydrate to sink site which ultimately led to positive increase in stover yield (Bunker et al., 2012). The results of this experiment showed that azotobacter seed inoculation showed significant increment in stover yield than no inoculation. This might be due to the better utilization of readily available fertilizer nitrogen or nitrogen from biological nitrogen fixation (BNF) which made plant more efficient in photosynthetic activity. Remarkably, higher but not significant net return was obtained with FYM (10 t ha^{-1}) than no FYM application. However, higher dose of nitrogen higher gave higher net return. Azotobacter seed inoculation showed significantly higher net return than that from no inoculation. The B:C ratio was not influenced significantly by FYM application (Table 2). However, higher B:C ratio was obtained with higher dose of nitrogen and azotobacter seed inoculation.

CONCLUSION

Hence, Rampur Hybrid-2 maize can be easily grown with recommended dose of nitrogen along with FYM and biofertilizer (*Azotobacter chroococcum)* to obtain highest grain yield and net economic return in winter at Terai of Nepal. Application of FYM together might help in increase effectiveness of azotobacter inoculation

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