Agropedology 2010, 20 (1), 74-79

Effect of INM on yield, quality and uptake of N, P and K by ginger

LIBENI YANTHAN, A. K. SINGH AND V. B. SINGH

School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema – 797106. Nagaland, India.

Abstract : A field experiment was conducted to evaluate the sole and integrated effect of nutrient application in ginger cv. Nadia. The experiment was laid out in randomized block design and replicated thrice. The results clearly indicate that combined application of 50% NPK + 50% pig manure significantly increased plant height, number of leaves/plants, number of tillers/clumps and leaf size followed by 50% NPK + 50% FYM and 50% NPK + 50% vermicompost. Different treatments significantly increased length of rhizome finger, diameter of rhizome finger and yield of fresh and cured ginger as compared to control. Combined application of 50% NPK + 50% pig manure recorded maximum fresh and cured yield, which were at par with 50% NPK + 50% FYM and 50% NPK + 50% vermicompost. Maximum uptake of N was observed with 50 % NPK + 50 % pig manure. However, maximum P and K uptake was observed with 50 % NPK + 50 % FYM. Soil available nutrients like N, P and K increased significantly with the application of various organic sources of nutrients in combination with fertilizers over the fertilizer treatment alone. Application of 50% NPK + 50% pig manure exhibited maximum gross return, net return and cost benefit ratio followed by 50% NPK + 50% FYM treatment.

Additional key words : *Organic manures, inorganic fertilizers, biofertilizers, nutrient uptake*

Introduction

Ginger (*Zingiber officinale* Rosc.) is an important horticultural crop in subtropical humid tract of North Eastern Hill region. It produces a pungent, aromatic rhizome that is valuable all over the world either as a spice or herbal medicine. A high protein meal with ginger is found to be effective in reducing the delayed nausea of chemotherapy and use of antiemetic medicines (Levine *et al.* 2008). Ginger is very effective in relieving the pain in women with primary dysmenorrhea as mefenamic acid and ibuprofen (Giti *et al.* 2009). India is the largest producer (36.5% of the world production) of ginger and exports 5000 tonnes to different countries having a value of Rs.2340 lakhs (Vadivel *et al.* 2006). Ginger requires heavy application of nutrients to sustain good yield. However, high rainfall hastens heavy loss of applied nutrients by run-off water in the region. Application of NPK @ 100 kg/ha each was found to be optimum for economical yield in Arunachal Pradesh (Singh and Arunachalam 1999). In ginger cultivation, application of organic manures and inorganic fertilizers is commonly practiced to increase the yield and quality of rhizome. This is also done with an objective to sustain the fertility of soil. A few reports on the use of organic manures and inorganic fertilizers in ginger

have also been documented (Khandkar and Nigam 1996; Singh and Singh 2007; Roy and Hore 2007). The productivity of ginger and soil fertility is declining day by day due to non-judicious and indiscriminate use of inorganic fertilizers. The information regarding combined use of different nutrient sources in ginger cultivation in Nagaland region is scanty. In the light of these observations, the present study was undertaken to investigate the comparative effect of organic manures, synthetic fertilizers and biofertilizers and their different combinations on yield, quality and uptake of N, P, and K by ginger crop.

Materials and Methods

A field experiment was conducted at the experimental farm of the School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema during the year 2005 - 2006. The field is located at an altitude of 310m above MSL (mean sea level) at geographical location of 25°45'45''N latitude and 93°53'04'' E longitude. The soil of the experimental field was sandy loam having pH 4.2, organic carbon 2.73%, available N, P_2O_5 and K_2O; 230.2, 18.5 and 210.6 kg/ha, respectively. The experiment was laid out in randomized block design with three replications. The treatments consisted of control, farmyard manure @ 20 tonnes/ha (0.6%N – 0.2%P – 0.6%K), vermicompost @ 5 tonnes/ha (2.5%N – 0.6%P – 2.1%K), pig manure @ 10 tonnes/ha (1.3%N – 0.3%P – 1.2%K), 100% recommended dose of NPK *i.e*, 100, 60, 60 kg/ha, 50% NPK + 50% FYM, 50% NPK + 50% vermicompost, 50% NPK + 50% pig manure, 100% NPK + *Azospirillum*, 100% FYM +*Azospirillum*, 100% pig manure + *Azospirillum* and 100% vermicompost + *Azospirillum*. Manures (farmyard manure, pig manure and vermicompost), phosphorus and potassium were applied at the time of planting. Nitrogen was applied in 2 split doses, first dose at the time of planting and second dose after 60 days of planting. The seed bits (rhizome bits) were treated with biofertilizer *Azospirillum* prior to planting @ 20g/ 10 kg seed bits. The healthy rhizome bits weighing about 20-25g each were planted at a spacing of 25 cm x 30cm in 2m x 2m plots and mulched with paddy straw to conserve the moisture and facilitate germination besides suppressing weed growth in early stage. The response of treatments was evaluated in terms of plant height, number of leaves/plant, size of leaves and number of tillers/ clump at maximum growth stage (150 days after planting). The crop was harvested 8 months after planting. Yield of green ginger was recorded after washing the rhizome thoroughly. Green ginger was later soaked in warm water to facilitate the removal of skin for dry ginger production. The scrapped produce was washed and dried in the sunlight for 3-4 days to 8-10% of moisture and the cured yield was recorded. Essential oil and oleoresin contents of ginger were extracted in petroleum ether and hexane solvent, respectively as described by Sadasivam and Manickam (1996). The economical analysis was also carried out. The statistical analysis was carried out as per procedures suggested by Gomez and Gomez (1984).

Results and Discussion

Growth, yield and quality

The growth attributes like number of leaves per plant, tillers per clump and leaf size were significantly affected by different treatments. Application of 50% NPK + 50% pig manure registered maximum number and size of leaves/plant and tillers/clumps followed by 50% NPK + 50% FYM and 50% FYM + 50% vermicompost (Table 1). The present findings are similar to observations made by Khandkar and Nigam (1996) and Singh and Singh (2007) who observed favourable effects of FYM and pig manure in enhancing the growth of ginger.

Application of 50% NPK + 50% pig manure produced maximum length of rhizome finger which further transformed in form of higher rhizome yield. Maximum fresh ginger yield (27.5 tonnes/ha) was recorded with 50% NPK + 50% pig manure and was statistically at par with 50% NPK + 50% FYM and 50% NPK + 50% vermicompost. Though maximum cured ginger yield (6.11 tonnes/ha) was recorded with

Table 1. Effect of integrated nutrient management on growth, yield and quality of ginger (Figures in parenthesis indicate essential oil and oleoresin, liter ha^{-1})

Treatments	Leaves/ plant	Height (cm)	Tillers/ clump	Leaf size (cm^2)	Finger length (cm)	Fresh yield (tones ha^{-1})	Cured yield (tonnes ha^{-1})	Essential oil (%)	Oleoresin (%)
Control	16.53	64.07	6.70	49.47	5.90	18.8	4.07	0.44 (82.94)	5.03 (204.72)
FYM @ 20 tonnes/ha	21.13	66.53	7.33	53.73	6.30	21.2	4.79	0.45 (95.62)	5.07 (243.15)
Vermicompost @ 5 tonnes/ha	20.67	65.20	7.00	51.14	6.20	21.0	4.72	0.45 (94.87)	5.07 (239.55)
Pig manure @ 10 tonnes/ ha	21.53	68.33	7.40	54.07	6.37	23.0	5.13	0.46 (105.80)	5.13 (263.16)
100% NPK (100: 60: 60 kg/ha)	21.80	69.27	7.42	57.35	6.40	23.9	5.36	0.46 (110.01)	5.17 (277.52)
50% NPK + 50% FYM	23.93	72.40	8.67	66.50	8.73	27.2	5.94	0.47 (128.07)	5.35 (317.79)
50% NPK + 50% vermicompost	23.47	71.16	8.10	66.27	7.83	26.7	5.90	0.46 (123.05)	5.27 (310.93)
50% NPK + 50% pig manure	25.87	76.07	8.87	69.33	8.97	27.5	6.11	0.47 (129.25)	5.35 (327.20)
100% NPK + *Azospirillum*	22.87	69.79	7.67	61.35	6.63	25.9	5.72	0.46 (119.21)	5.20 (297.85)
100% FYM + *Azospirillum*	23.40	70.60	7.89	65.62	7.27	26.3	5.86	0.46 (121.13)	5.26 (308.65)
100% pig manure + *Azospirillum*	23.27	69.82	7.73	62.91	7.03	26.0	5.78	0.47 (122.20)	5.23 (302.34)
100% vermicompost + *Azospirillum*	22.00	69.68	7.46	61.54	6.47	23.9	5.39	0.45 (107.92)	5.17 (278.86)
CD (P=0.05)	2.19	NS	0.86	8.23	1.32	2.0	0.4	N.S.	N.S.

50% NPK + 50% pig manure, yet it was at par with 50% NPK + 50% FYM, 50% NPK + 50% vermicompost and 100% FYM + *Azospirillum* and 100% pig manure + *Azospirillum* treatments. *Azospirillum* treatments might have led to increase of plant growth by producing growth promoting substances as well as more nitrogen contributed to the soil due to enhanced microbial activities (Selvarajan and Chezhiyan 2001). Lowest cured ginger yield was recorded with control. Organic manures in combination with biofertilizers were also found substantially effective in enhancing the yield of ginger in comparison to organic manure or inorganic fertilizer alone. Roy and Hore (2007) also obtained good response of fertilization in enhancing the yield by integration of organic manures with inorganic fertilizers in ginger.

Application of various treatments did not show any significant effect on the quality parameters of ginger, like percentage of oil and oleoresin content. However, maximum projected yield of oil (129.25

liter/ha) and oleoresin (327.93 liter/ha) was obtained with 50% NPK + 50% pig manure and minimum oil (82.94 liter/ha) and oleoresin content (204.72 liter/ha) in control. Contrary to this, Singh and Singh (2007) reported that FYM and pig manure significantly increased the yield of ginger. Ginger with comparatively higher oil and oleoresin content is rated as of better quality.

Nutrient uptake and fertility build-up

Various treatments significantly increased the uptake of nitrogen, phosphorus and potassium (Table 2). Maximum uptake of nitrogen (141.05 kg/ha) was observed with treatment combination 50% NPK+ 50% pig manure. However, maximum uptake of phosphorus (15.38 kg/ha) and potassium (214.03 kg/ha) was recorded with 50% NPK +50% FYM and was at par with 50% NPK+ 50% pig manure and 100% FYM + *Azospirillum*. Thakur and Sharma (1997) reported that the uptake of nutrients by ginger crop can be increased by the application of inorganic fertilizers. Singh and Singh (2007) have shown increased uptake of nutrients in ginger crop under Nagaland conditions with combined application of organic manures and inorganic fertilizers.

The different treatments have imparted unique impact on residual soil fertility (Table 3). The data reveal that different treatments significantly affected the available nitrogen, phosphorus and potassium content of soil after harvest except that of organic carbon content . The control has shown a marked reduction in available N, P, K and organic carbon in soil due to depletion of these nutrients from soil. Application of 100% NPK recorded the maximum (3063.6 kg ha^{-1}) of residual soil N followed by FYM @ 20 tonnes/ha (280.5 kg ha^{-1}). Increase in available nitrogen with 100% NPK and FYM may be due to the direct addition of nitrogen through inorganic sources and FYM to the available pool of the soil. The decomposition of organic matter is accompanied by the release of appreciable quantities of carbon dioxide which, when dissolved in water, forms carbonic acid which is capable of weathering certain primary minerals. The increase in available N due to organic materials application might be also attributed to the greater multiplication of microbes caused by the addition of organic materials for the conversion of organically bound N to inorganic form. The favourable soil conditions under FYM addition might have helped in the mineralization of soil N leading to build up of

Table 2. Effect of integrated nutrient management on plant uptake of N, P and K and their contents in soil

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Organic C in soil (%)	Available macronutrients in soil		
					N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
Initial value (% / available)	-	-	-	2.7	230.2	18.5	210.6
Control	72.64	8.71	125.16	2.6	201.5	15.4	205.0
FYM @ 20 tonnes/ha	91.86	10.62	157.42	2.9	280.5	20.1	216.6
Vermicompost @ 5 tonnes/ha	83.06	9.76	154.16	2.7	242.4	17.2	218.0
Pig manure @ 10 tonnes/ ha	100.87	12.17	175.79	2.8	250.9	18.3	210.5
100% NPK (100: 60: 60 kg/ha)	116.89	12.13	184.16	2.7	306.6	19.0	209.1
50% NPK + 50% FYM	140.34	15.38	214.03	2.9	212.1	18.7	214.3
50% NPK + 50% vermicompost	121.01	13.95	199.4	2.7	226.0	19.6	207.9
50% NPK + 50% pig manure	141.05	14.44	217.66	2.8	241.3	16.5	209.6
100% NPK + *Azospirillum*	128.41	13.85	199.15	2.7	261.8	19.4	206.0
100% FYM + *Azospirillum*	130.49	14.39	200.82	2.7	242.7	17.4	220.3
100% pig manure + *Azospirillum*	133.67	13.11	200.34	2.8	238.3	16.6	211.6
100% vermicompost + *Azospirillum*	121.75	12.70	182.71	2.7	241.2	18.5	217.6
CD (P=0.05)	5.53	1.36	8.06	N.S.	17.3	0.9	8.4

Table 3. Economics of ginger cultivation

Treatments	Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	Cost: Benefit Ratio
Control	43920	150936	107016	1: 3.43
FYM @ 20 tonnes/ha	51920	170000	118080	1: 3.27
Vermicompost @ 5 tonnes/ha	73920	168664	94744	1: 2.28
Pig manure @ 10 tonnes/ ha	51920	184000	132080	1: 3.54
100% NPK (100: 60: 60 kg/ha)	49050	191336	142286	1: 3.90
50% NPK + 50% FYM	50485	218000	167515	1: 4.31
50% NPK + 50% vermicompost	61485	214000	152515	1: 3.48
50% NPK + 50% pig manure	50485	220000	169515	1: 4.35
100% NPK + *Azospirillum*	49100	207336	158236	1: 4.22
100% FYM + *Azospirillum*	51970	210664	158694	1: 4.05
100% pig manure + *Azospirillum*	51970	208000	156030	1: 4.00
100% vermicompost+ *Azospirillum*	73970	191864	117894	1: 2.59

higher available N. Slight improvement in organic carbon content of soil (0.2%) was observed under FYM @ 20 tonnes/ha and 50% FYM + 50% NPK treatments as compared to initial value; the impact was, however, not significant. The increase in organic carbon content in the manurial treatment combination is attributed to direct incorporation of organic matter in the soil. The maximum residual P content (20.1 kg/ha) was recorded with FYM @ 20 tonnes/ha treatment which was observed to be at par with 100% NPK + *Azospirillum* and 50% NPK + 50% vermicompost treatment. The appreciable build up in available P with organics and inorganics may be attributed to the influence of organic manure in increasing the labile P in soil through complexing of cations like Ca^{2+} and Mg^{2+}, which are mainly responsible for the fixation of phosphorus. Generally, addition of organic manures like FYM, with inorganic fertilizers had the beneficial effect in increasing the phosphate availability (Balaguravaiah *et al.* 2005). The control treatment recorded the lowest (15.4 kg/ha) residual P content. 100% FYM + *Azospirillum* treatment recorded the maximum (220.3 kg/ha) residual K content followed by vermicompost @ 5 tonnes/ha and FYM @ 20 tonnes/ha. Increase in available potassium due to FYM and vermicompost application may be attributed to the direct addition of potassium to the available pool of the soil. The beneficial effect of FYM and vermicompost on the available K may be ascribed to the reduction of fixation and release of K due to the interaction of organic matter with clay besides the direct K addition to the available K pool of the soil. Increase in available K due to FYM was reported by Tandon (1987). Minimum K content was recorded with control. Increased availability of nutrients in the soil was brought about by the combined use of inorganic fertilizers, organic manures and biofertilizers. Above results are in agreement with the findings of Anwar *et al.* (2005).

Economics of crop

It is evident from the data presented in table 3 that the most profitable treatment combination was 50% NPK + 50% pig manure followed by 50% NPK + 50% FYM which resulted in maximum cost benefit ratio 1:4.35 and 1:4.31, respectively. The net return obtained due to 50% NPK + 50% pig manure treatment was observed to be higher by Rs.62,499/- over control suggesting the better economics of fertilizer use. The net return was invariably high with combined application of organic manures and inorganic fertilizers. Almost all treatments exhibited better return as compared to control. In a similar study, Nath and Karla (2000) calculated economics of ginger and found

maximum net profit (Rs.97,175) and cost benefit ratio of ginger with application of 100:50:50 kg/ha NPK along with biofertilizers.

Conclusion

The combined application of 50% NPK + 50% pig manure is a better source of nutrient input for obtaining higher yield as well as in sustaining soil fertility under the foothill agro-climate conditions. It also suggests that integrated nutrient management is a viable option of commercial ginger production.

References

Anwar, M., Patra, D.D., Chand, S., Kumar, A., Nagvi, A.A. and Khanuja, S.P.S. (2005). Effect of organic manures, inorganic fertilizers on growth, herb and oil yield, nutrient accumulation and oil quality of French basil. *Communication in Soil Science and Plant Analysis* **36,** 1737-1746.

Balaguravaiah, D., Adinarayana, G., Prathap, S. and Reddy, T.Yellamanda. (2005) Influence of long-term use of inorganic and organic manures on soil fertility and sustainable productivity of rainfed groundnut in Alfisols. *Journal of the Indian Society of Soil Science*, **53**, 608-611.

Giti, Ozgoli, Marjan Goli and Fariborz Moattar (2009) Comparison of effects of ginger, mefenamic acid and ibuprofen on pain in women with primary dysmenorrhea. *The Journal of Alternative and Complementary Medicine*, **15**, 129-132.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons, New York pp. 97-115.

Khandkar, U.R. and Nigam, K.B. (1996). Effect of farmyard manure and fertility level on growth and yield of ginger (*Zingiber officinale*). *Indian Journal of Agricultural Sciences* **66**, 549 – 550.

Max E. Levine, Marcum G.Gillis, Sara Yanchis Koch, Anne C.Voss, Robert M. Stern and Kenneth L. Koch (2008) Protein and ginger for the treatment of chemotherapy-induced delayed Nausea. *The Journal of Alternative and Complementary Medicine*, **14**, 545-551.

Nath, B. and Karla, B.N. (2000). Studies on effect of biofertilizers in ginger. *Indian Journal of Horticulture* **57,** 168 – 171.

Roy, S.S. and Hore, J.K. (2007). Influence of organic manures on growth and yield of ginger. *Journal of Plantation Crops* **35,** 52-55.

Sadasivam, V.B. and Manickam, A. (1996). Biochemical Methods. 2nd Ed. New Age International Publication, Calcutta, India pp 22.

Selvarajan, M. and Chezhiyan, N. (2001). Studies on the influence of *Azospirillum* and different levels of nitrogen on growth and yield of turmeric (*Curcuma longa* L.). *South Indian Horticulture* **49** (Special) pp. 140- 141.

Singh, N.D. and Arunachalam, A. (1999). Effect of NPK on growth and yield of ginger. *Indian Journal of Horticulture* **56,** 354 – 359.

Singh, V.B. and Singh, A.K. (2007). Effect of types of organic manures and method of nitrogen application on growth, yield and quality of ginger. *Environment and Ecology* **25,** 103 – 105.

Tandon, H.L.S. (1987) Phosphorus Research and Agricultural Production in India, FDCO, New Delhi.

Thakur, S.K. and Sharma, S.K. (1997). Response of ginger to nitrogen and phosphorus in sub-tropical zone of Himachal Pradesh. *Indian Journal of Agriculture Research* **31,** 195 – 198.

Vadivel, V., Senthilkumaran, P. and Madhusoodanan, K.J. (2006). Problems and perspective of ginger production and report. *Spice India,* April, 2006 pp 38 – 42.

Received : May 2009 *Accepted : January 2010*