Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Sciences 5 (6): 1012-1016, 2006
ISSN 1682-3974

Nitrogen Fertilizer Effect on the Agronomic Aspects of *Asparagus racemosus*

[1]K.L. Hossain, [1]M.M. Rahman, [2]M.A. Banu, [3]T.R. Khan and [4] M.S. Ali
[1]Department of Agroforestry, [2]Department of Agricultural Chemistry,
[3]Department of Agronomy, [4]Department of Agricultural Chemistry,
Bangladesh Agricultural University, Mymensingh, Bangladesh

Abstract: This research paper attempts to investigate the performance of *Asparagus racemosus* grown by the application of different forms and doses of nitrogen fertilizer at the Germplasm Centre (GPC) of the Fruit Tree Improvement Program (FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh during February to October, 2005. The treatments consisted of prilled urea and super granule urea at 0, 100, 200 and 300 kg N ha^{-1} concentrations. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The number, length, diameter and both fresh and dry weight of tuberous roots were found higher with super granule urea than that of prilled urea. Root protein content was found to be 25.20% higher in super granule urea treated plants compared to prilled urea. The rates of nitrogen also had a significant effect on plant height, leaves number and number, length, diameter and both fresh and dry weight of tuberous roots when compared to 0 kg N kg ha^{-1} to the rest of the rates. Root protein content was 21.87, 12.5 and 14.06% higher than the control at the 100, 200 and 300 kg N ha^{-1} concentrations, respectively. Therefore, application of 100 kg N ha^{-1} as super granule urea was found to be sufficient for the sustainable production of tuberous roots of *Asparagus*.

Key words: *Asparagus racemosus*, nitrogen fertilizer, tuberous roots

INTRODUCTION

Asparagus racemosus is one of the important medicinal plants extensively used by the traditional practitioners in Bangladesh for its medicinal value. Farmers of our country are very poor and cannot afford to take expensive allelopathic treatments. They usually grow *Asparagus* in homestead agroforestry systems for their use in herbal treatments. The leaves and the tuberous root of *Asparagus* are medically important to cure minor to severe diseases, but the tuberous root is the most important for its high medicinal value. Mandal *et al.* (2000) reported that the tuberous roots of *Asparagus* are useful in dysentery, tumour, inflammations, tuberculosis, leprosy, biliousness and diseases of blood, eye, kidney and liver. However, the lower production of medicinal plant in Bangladesh is not an indication of the low yielding potential but of the fact that the lowest production may be attributed to a number of reasons such as unavailability of quality vegetative parts of improved varieties, fertilizer management, diseases, insect infestation and improper irrigation. Soils of Bangladesh are often deficient in nitrogen; therefore, it is important to apply fertilizer for satisfactory growth and yield.

In some cases medicinal plants require large amounts of readily available fertilizers (Gupta and Shukla, 1977). Nitrogen is especially critical for increasing *Asparagus* production and has aptly been recognized as the central element for agricultural development (Mukhopadhyay *et al.*, 1986). More than any other nutrient nitrogen influences vegetative growth and yield of medicinal plants. Nitrogen is essential for building up protoplasm and protein which induces cell division and initial meristematic activity (Singh and Kumar, 1969). Nitrogen has the largest effect on yield and quality of medicinal plants (Xin *et al.*, 1997); it also promotes vegetative growth and fruit set (Bose and Som, 1990).

Judicious application of fertilizer is necessary to optimize the nutrient supply for proper growth and development of medicinal plants. Nitrogen rates have been shown to have different effects for some growth parameters of *Asparagus racemosus*. The productive life of *Asparagus* plant depends on fertilizer treatments; the best amount of fertilizer to use was about 35 tons of compost mixed with 400 kilos of complete fertilizer per hectare (ACRI, 1999) Application of 50 kg N ha^{-1} was enough for tuberous root production at most sites (Krarup *et al.*, 2002). Excessive N can result in less

Corresponding Author: Kazi Liaquat Hossain, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, Bangladesh

vigorous spears while N deficiency reduces quality. Soil N concentration of 90 kg ha^{-1} in the 0-90 cm soil layer after the third year of cultivation are recommended for both optimum plant growth and minimum ground water contamination (Paschold *et al*., 1999).

Balanced fertilizer nutrients can also play a vital role in sustaining high yield of medicinal plants as well as maintaining fertility status of soils on a long term basis. Moreover, recent agricultural policy in Bangladesh emphasized on increasing yield vertically by using profitable nitrogen rates. Therefore, the present piece of research was undertaken with nitrogen levels to investigate their effects on agronomic characters of the *Asparagus racemosus*.

MATERIALS AND METHODS

The research was conducted at the Germplasm Centre, Department of Horticulture, Bangladesh Agricultural University, Mymensingh during February to November, 2005. The experimental field is located at 24°75' N latitude and 90°50' E longitude, with a height of 18 m above the sea level. The agro-ecological region is the Old Brahmaputra Floodplain (AEZ-9) which occupies the Brahmaputra sediments, deposited before the river shifted into its present channel about 200 years ago (UNDP and FAO, 1988). The soil of the experimental site is silty loam belonging to the Brahmaputra alluvial tracts (Anonymous, 1960). The experimental field was a medium high land having pH value of 6.50-7.00.

The experimental field was cultivated 20 days before sowing with a tractor drawn disc plough. It was further ploughed and cross ploughed 6 times with the country plough each time followed by laddering. Triple Super Phosphate (TSP), Muriate Of Potash (MOP) and cowdung were applied at the rate of 200, 300 kg and 10 t ha^{-1} during the final land preparation. The land was cleaned by collecting and removing the weeds, stubbles, crop residues etc. The plots were prepared and well drainage systems were made around individual plots. Seeds were collected from plants at the BAU, Horticultural farm. The seedlings were planted by the dibbling method in January 20, 2005. The seedlings were placed in furrows and immediately covered by soil. A spacing of 40×25 cm was maintained with continuous distribution of seedlings in rows in each plot.

Experimental treatments

Factor A: Forms of nitrogen fertilizers as:

- N_1 (Urea Prilled)
- N_2 (Urea Super Granule)

Factor B: Different doses of nitrogen fertilizers as:

- D_0 (0 kg N ha^{-1})
- D_1 (100 kg N ha^{-1})
- D_2 (200 kg N ha^{-1})
- D_3 (300 kg N ha^{-1})

Experimental design and layout: The experiment was laid out in a Randomized Complete Block Design (RCBD) with 8 treatments in each block and 3 replications. The experimental area was divided into three blocks. Each block was divided into 8 unit plots. Block to block distance was 75 cm. Each plot contained three plants. Total number of plots was 24. The area of the each unit plot was 1 m^2 (1×1 m). The distance between two unit plots were 50 cm. There was a weed-free border of 10 cm around the experimental field.

Application of fertilizers: Half of the entire amount of the nitrogen fertilizer treatments was applied after one month of transplanting and the remainder applied after two months of first fertilizer application. The fertilizer was applied in a ring around the plants.

Intercultural operations: The plots were infested with durba (*Cynodone dectylon*) and other weeds. The first weeding was done 20 days after transplanting when the plants were 15-20 cm high. Additional weeding was done at 25-30 days interval. The experimental plot was irrigated twice by a watering cane. The first irrigation was required at 20 days after planting and the second at 55 days. At the time of irrigation, sufficient care was taken to avoid the flow of irrigation water from one plot to another. The field was frequently observed for changes in plant characters, pests and diseases of plants.

Harvesting and data collection: The tuberous roots were harvested on the 18th August, 2005 when the plants were fully matured. Randomly selected plants from each plot were harvested separately and plant height (cm), number of leaves, branches and collar diameter $plant^{-1}$ and also number, length (cm) and diameter (cm) of the tuberous root were recorded. The length and diameter of tubers were measured with a slide caliper. Fresh weight of tuberous roots (g) was taken just after harvest and dry weight of tuberous roots was recorded after oven drying at 70°C. The dried samples were ground by grinding machine for chemical analysis. The prepared samples were stored in paper bags and held in desiccators until analyzed. Chemical analysis included the estimation of protein and N.

Analysis of tubers: The samples were digested and extracts were prepared following the method by Jackson (1962). Sample extracts were held in plastic bottles for the analysis. Root nitrogen of tuberous roots was determined by the semi-micro kjeldahl method (Page *et al*., 1989). Root protein content was also calculated.

Analysis of data: Data were subjected to an analysis of variance and the mean results were compared following the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of different forms of nitrogen fertilizer on agronomic characters, root protein and nitrogen content of *Asparagus racemosus*: Different forms of nitrogen fertilizer had a significant effect on all the yield contributing characters of *Asparagus*. Root protein and nitrogen content were also significantly influenced. Urea super granule produced the highest plant height (92.737 cm), collar diameter (1.56 cm), branch (10.33) and leaves plant^{-1} (271.248), along with the highest number (38.13), length (8.38 cm) and diameter (1.015 cm) of tuberous roots. The highest fresh (89.08 g) and dry weight (30.35 g) were also obtained with the urea super granule treatment. In contrast, the lowest of yield contributing characters and fresh and dry weight of tuberous roots were obtained from urea prilled treatments. The highest root protein (1.50%) and nitrogen (0.24%) content were found from urea super granule and their corresponding lowest content which is 0.22 and 1.37%, respectively were found from urea prilled (Table 1).

Effect of different doses of nitrogen fertilizer on the agronomic characters, root nitrogen and protein content of *Asparagus racemosus*: Different nitrogen doses exerted significant effect on all the agronomic parameters along with root protein and nitrogen content. The highest plant height (115.50 cm), number of leaves plant^{-1} (435.830) and number (57.96), length (8.78 cm) and diameter (1.105 cm) of tuberous roots were found from 100 kg N ha^{-1} treatment. The highest fresh (122.3 g) and dry weight (37.14 g) of tuberous roots were also recorded from 100 kg N ha^{-1}. The highest root protein (1.75%) and nitrogen content (0.28%) were obtained from 100 kg N ha^{-1}. Control with no N-fertilizer gave the lowest values for all the yield contributing characters and nutrient content of *Asparagus*. Apart from the 100 kg N ha^{-1} treatment, the highest number of branches plant^{-1} (10.995) was found from 200 kg N ha^{-1} treatment while 300 kg N ha^{-1} produced the highest value (1.57 cm) of collar diameter (Table 2).

Interaction effect (different doses × forms) on the agronomic characters, root nitrogen and protein content of *Asparagus racemosus*: The interaction showed a significant variation in maximum cases except diameter and dry weight of tuberous roots of *Asparagus*. Urea super granule with 100 kg N ha^{-1} produced the tallest plant (136.00 cm), the highest number (60.25) and length (8.31 cm) of tuberous roots and fresh weight (130.50 g) per plant. The highest number of branches plant^{-1} (13.66) and collar diameter (2.05 cm) were obtained from urea prilled with 100 kg N ha^{-1}. Urea super granule with 300 kg N ha^{-1} gave the similar number of branch plant^{-1} (13.66). The lowest number of branch plant^{-1} was obtained when the plant was fertilized with urea prilled with 300 kg N ha^{-1}. The highest protein content (1.81%) was obtained from urea super granule when the plant was fertilized with 100 kg N ha^{-1} and the lowest (70.66 cm) from control (Table 3).

An evaluation of the effect of different forms and doses of N on the growth and tuberous root production of *Asparagus racemosus* revealed that the urea super granule at the rate of 100 kg N ha^{-1} gave the best result compared to other rates of nitrogen. The number, length, diameter and both fresh and dry weight of tuberous roots were found higher with urea super granule than that of prilled urea. Root protein content was also found 25.20% higher in urea super granule treatment. Differences in yield and growth parameters can be explained by the solubility and leaching characteristics of the different forms of urea. Prilled urea quickly dissolves in soil water and is also readily leached below the crop root zone. On the other hand, urea super granule dissolves slowly and releases nitrogen in the form NO_3^- or NH_4^+ for longer period of time. Though not measured, it is likely that urea super granule nitrogen was more available for plant uptake for longer period of time than prilled urea. Root protein content was found 21.87, 12.5 and 14.06% higher over control in 100, 200 and 300 kg N ha^{-1} treatments, respectively. Application of 100 kg N ha^{-1} was found more effective for the tuberous root production of *Asparagus* as observed in the present study is in relation with the observation of Krarup *et al.* (2002). He found 50 kg N ha^{-1} was enough rather than applying higher concentration of nitrogen such as 100, 150 and 200 kg N ha^{-1}. This is due to the fact that higher concentrations of N ion in the soil limit the uptake of other essential macro and micro nutrients by the plant. Paschold *et al.* (1999) reported that excessive N supply can result in less vigorous spears of *Asparagus* while N deficiency reduces quality.

Table 1: Effect of different forms of nitrogen fertilizer on the agronomic characters, root protein and nitrogen content of *Asparagus racemosus*

Forms of nitrogenous fertilizers	Plant height (cm)	No. of branch plant^{-1}	No. of leaves plant^{-1}	Collar diameter plant^{-1} (cm)	No. of tuberous roots plant^{-1}	Length of tuberous root (cm)	Diameter of tuberous root (cm)	Fresh weight of tuberous root (g)	Dry weight of tuberous root (g)	Root nitrogen (%)	Root protein content (%)
Prilled urea	78.58	8.33	271.24	1.383	35.93	7.08	0.98	79.52	27.36	0.22	1.37
Urea super granule	92.73	10.33	252.91	1.563	38.13	8.38	1.01	89.08	30.35	0.242	1.50
S $\overline{X}$	1.40	0.43	16.48	0.09	0.65	0.15	0.01	1.02	0.69	0.01	0.018
LSD	4.26	1.32	49.97	0.29	1.97	0.46	0.03	3.79	2.10	0.02	0.05
CV (%)	4.02	11.46	10.40	15.86	4.31	4.90	3.50	2.99	5.88	3.32	3.38
Level of significance	**	**	**	*	**	**	*	**	**	**	**

** Significant at 1% level of probability, * Significant at 5% level of probability

Table 2: Effect of different doses of nitrogen fertilizer on the agronomic characters, root protein and nitrogen content of *Asparagus racemosus*

Doses of nitrogenous fertilizers	Plant height (cm)	No. of branch plant^{-1}	No. of leaves plant^{-1}	Collar diameter plant^{-1} (cm)	No. of tuberous roots plant^{-1}	Length of tuberous root (cm)	Diameter of tuberous root (cm)	Fresh weight of tuberous root (g)	Dry weight of tuberous root (g)	Root nitrogen (%)	Root protein content (%)
0 kg N ha^{-1}	72.00c	6.33b	140.83c	0.94c	29.28b	6.29c	0.82d	53.38d	17.85c	0.20c	1.25c
100 kg N ha^{-1}	115.5a	10.99a	435.83a	1.87a	57.96a	8.78a	1.10a	122.3a	37.14a	0.28a	1.75a
200 kg N ha^{-1}	76.00bc	9.66a	229.16b	1.49b	31.22b	7.76b	1.01c	82.78b	29.38b	0.25b	1.56b
300 kg N ha^{-1}	79.14b	10.33a	242.49b	1.57b	29.67b	8.09b	1.06d	83.88b	31.05b	0.26b	1.62b
S $\overline{X}$	1.40	0.43	16.48	0.09	0.65	0.15	0.01	1.02	0.69	0.01	0.01
LSD	4.26	1.32	49.97	0.29	1.97	0.46	0.03	3.79	2.1	0.01	0.05
CV (%)	4.02	11.46	10.40	15.86	4.31	4.90	3.50	2.99	5.88	3.32	3.38
Level of significance	**	**	**	**	**	**	**	**	**	**	**

** Significant at 1% level of probability. Means with different letter(s) differ significantly from each other within the same column

Table 3: Combined effect of different doses and forms of nitrogen fertilizer on the agronomic characters, root protein and nitrogen content of *Asparagus racemosus*

Treatments	Plant height (cm)	No. of branch plant^{-1}	No. of leaves plant^{-1}	Collar diameter plant^{-1} (cm)	No of tuberous roots plant^{-1}	Length of tuberous root (cm)	Diameter of tuberous root (cm)	Fresh weight of tuberous root (g)	Dry weight of tuberous root (g)	Root nitrogen (%)	Root protein content (%)
N_1D_0	70.00e	5.33c	123.30c	1.10b	28.66d	5.46e	0.80	50.50g	15.56	0.19ef	1.18e
N_1D_1	95.00b	13.66a	620.00a	2.05a	55.66b	8.31bc	1.09	114.0b	35.38	0.27b	1.68c
N_1D_2	78.33cd	7.33bc	173.30c	1.23b	29.91cd	6.66d	1.02	73.10e	30.00	0.24c	1.50d
N_1D_3	80.00c	7.00bc	168.30c	1.15b	30.33cd	7.90c	1.04	80.50d	30.05	0.245c	1.53d
N_2D_0	74.00de	7.33bc	158.30c	0.79b	29.10cd	7.13d	0.85	56.25f	20.15	0.22d	1.37c
N_2D_1	136.00a	8.33b	251.70b	1.70a	60.25a	9.25a	1.12	130.50a	38.90	0.29a	1.81a
N_3D_2	79.95cd	12.00a	285.00b	1.76a	30.25cd	8.29bc	1.01	80.35d	30.25	0.26b	1.62b
N_4D_3	81.00c	13.66a	316.00b	2.00a	32.11c	8.86ab	1.08	89.25c	32.10	0.26b	1.62b
S $\overline{X}$	1.987	0.62	23.30	0.14	0.92	0.21	0.01	1.45	0.97	0.01	0.02
LSD	6.026	1.87	70.67	0.41	2.79	0.66	0.05	4.40	2.96	0.01	0.07
CV (%)	4.02	11.46	13.40	12.86	4.31	4.90	3.50	2.99	5.88	3.32	3.38
Level of significance	**	**	**	**	*	**	NS	*	NS	*	**

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Non-significant. Means with different letter(s) differ significantly from each other within the same column; N_1D_0 and N_2D_0 = Without fertilizer or control, N_1D_1 = Urea Prilled with 0 kg N ha^{-1}, N_1D_2 = Urea Prilled with 200 kg N ha^{-1}, N_1D_3 = Urea Prilled with 300 kg N ha^{-1}, N_2D_1 = Urea Super Granule with 100 kg N ha^{-1}, N_3D_2 = Urea Super Granule with 200 kg N ha^{-1}, N_4D_3 = Urea Super Granule with 300 kg N ha^{-1}

An important limitation of our study was that no soil analysis was done to know the exact concentration of soil nitrogen before applying fertilizers nor was nitrogen monitored over the course of the experiment. Nitrogen fertilization should be based on the analysis of soil nitrogen, especially if organic fertilizers are used (Paschold *et al*., 1999). However, from the present study, we concluded that application of urea super granule at 100 kg N ha^{-1} was highly effective for optimum growth and tuberous root production of *Asparagus*. A higher rate of nitrogen fertilizer should not be used considering production cost, its negative impact on tuberous root production and the risk of ground water contamination through leaching.

REFERENCES

ACRI (Agricultural Crops Research Institute), 1999. The productive life of *Asparagus*. Cultural Directions for Philippines, ACRI, pp: 1-86.

Anonymous, 1960. Soil survey report of sadar sub-division in the district of Mymensingh. Agric. Chem. Bull. 6.

Bose, T.K. and M.G. Som, 1990. Vegetable crops in India. Published by B. Mitra and Naya Prokash, 206 Bidhan Sarani, Calcutta. Adv. Hortic. Sci., 7: 57-60.

Gupta, A. and V. Shukla, 1997. response of tomato (*Lycopersicum esculentum* Mill.) to plant spacing, nitrogen, phosphorus and potassium fertilization. Indian J. Hortic., 33-34: 270-276.

Jackson, M.L., 1962. Soil Chemical Analysis. Constable and Co. Ltd. London. 65.

Krarup, C., A. Krarup, R. Pertierra and A. Uragami, 2002. Growth of *Asparagus* crowns with increasing nitrogen rates at three different sites. Proccedings of the 10th International *Asparagus* Symposium Niigata, Japan, 30 August to 2 September, 2001. Acta Horticulture, No. 589: 145-150.

Mandal, S.C., K.A. Kumar, L. Mohana, S. Sinha, T. Murugesan and B.P. Saha, 2000. Antitussive effect of *Asparagus racemosus* root against sulphur dioxide induced cough in mice. Fitoterapia, 71: 686-689.

Mukhopadhyay, D., D.M. Eunus and M.M. Haque, 1986. Response of major crop to balanced fertilizer application. DAE and FAO. Pub. Field Document No. 5, pp: 1.

Page, A.L., R.H. Miller and D.R. Keeny, 1989. Methods of Soil Analysis. Part II, 2nd Edn., Amer. Soc. Agron. Inc. Madison, Wisconsin, USA.

Paschold, P.J., G. Hermann and B. Artell, 1999. Nitrogen, yields, spear quality and Nmin residues of *Asparagus*. Gemuse Munchen, 35: 588-592.

Singh, K. and S. Kumar, 1969. Effect of nitrogen and phosphorus fertilization on the growth and yield o onion (*Allium cepa* L.). JU. Res. Ludhiana, 6: 764-768.

UNDP (United Nations Development Program) and FAO (Food and Agricultural Organization), 1988. Land Resource Appraisal of Bangladesh for Agricultural Development. Rep. 2. Agroecol. Reg. Bangladesh. U.N. Dev. Prog. Food Agric. Org., pp: 212-221.

Xin, X.Y., L.J. Hui and H. Lili, 1997. The effect of N.P.K. mixed application on yields and quality of tomato in solar green house. Chines Veg., 4: 10-13.