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Effect of different seeding densities and nitrogen levels on growth, forage yield and quality attributes of Cluster bean (*Cyamoposis tetragonoloba* Tuab.)

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The cluster bean is promising fodder for live stock in arid and semi arid regions of Pakistan. Therefore, a field experiment to evaluate the effect of different nitrogen levels (0, 30 and 45 kg ha $^{-1}$) and seeding rates (30, 40 and 50 kg ha $^{-1}$) on forage yield and quality parameters of cluster bean were conducted at Agronomic Research Farm, University of Agriculture, Faisalabad. The experiment was performed in randomized complete block design (RCBD) with factorial arrangements. The nitrogen application significantly improved all the yield (except plant population) and quality parameters and the maximum values for all parameters were recorded when nitrogen was applied at 45 kg ha^{-1}. Plant population, green forage yield and dry matter yield were significantly improved by increasing the seeding density. The seeding densities were not significant effect on plant height, stem diameter, crude protein and crude fibre contents. The number of branches per plant and ash contents were decreased with increasing seeding densities. The interactive effects of nitrogen and seeding rates were not significant for all observation except fresh and dry matter yield. It can be concluded that higher forage yield of cluster bean under agro climatic conditions of Faisalabad, Pakistan can be obtained using a seed and nitrogen rates of 50 and 45 kg ha^{-1}, respectively.

Key words: Cluster bean, seed rates, nitrogen levels, forage yield and quality

Introduction

The agriculture economy of Pakistan is predominantly depended on livestock and its share in GDP added by agriculture sector is 53.2 % (GOP, 2010). The unavailability of green forages to livestock in sufficient amount is potential threat to livestock industry in Pakistan. We have a short fall of 25 % in total digestible nutrient (TDN) and 40 % in digestible protein on the basis of nutritional requirement (Anonymous, 2003). The protein shortfall can be overcome by feeding animals with legume forages due to their higher protein

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contents. The cluster been is tall and bushy annual legume mostly grown on sandy soils of arid and semi arid regions of India, Pakistan and United States (Undersander *et al*., 2006). The semi arid regions are mainly characterized by deficient moisture and nutrients where cluster bean can be the best option as it has ability to withstand in moisture deficient and less fertile soils. It is delicious forage for camels both in fresh and wilted forms. It can be used in dry form during the forage shortage periods of winter. The yield obtained at farmer's field is much below than the country requirement which is mainly attributed towards low and erratic rainfall, lower nutrient availability and use of inappropriate seed rates. The seed rates and nitrogen application are vital factor for obtaining higher yield of crops.

It has been recognized that the careful use of fertilizer can improve yield of crops (Sharma *et al.,* 1996). The nitrogen is major plant nutrient and plays an important role in the plant growth and development (Taiz and Zeiger, 2006). Although major nitrogen requirement of legumes is met by biological nitrogen fixing rhizobia but soils of Pakistan are low in rhizobia due to low organic matter contents. Therefore, nitrogen availability to the legumes can be increased either with manual inoculation or with application of commercial nitrogen fertilizer. The deficient soils require nitrogen as starter dose for leguminous crop (Osborne and Riedell, 2006). The nitrogen not only improves the yield and yield components of legumes (Baboo and Mishra, 2001; Marton and Kadar, 1998) but also affects the biological nitrogen fixation (Akter *et al.*, 1998). Therefore, selection of optimum nitrogen rates is essential for better performance of both crop and inoculated rhizobia.

The selection of optimum seed rate is another important cultural practice and is mainly controlled by seed size, vigor, germination % age, sowing methods and required plant population of the crop. The interest in studies regarding the seed rates is further increased due to sky touching prices of good quality seed. Both higher and lower seed rates than the optimum is the principle cause of low yield in Pakistan (Ahmad *et al*., 2004). In general farmers use higher seed rates if they are using their own seed and lower seed rates if using expensive seed. The seeding density affects the plant growth due to its direct relation with plant population. The higher plant population increases competition among plants for nutrients, light and space, while lower population density causes inefficient use of natural resources and inputs (Lone *et al.,* 2010). The total dry weight of leaves, leaf area index (LAI), crop growth rates (CGR), relative crop growth rate (RGR) were decreased with increasing plant densities (Rad *et al.,* 1999). The earlier studies showed a fluctuation in growth and yield of cluster bean at various seeding rates (Anonymous, 2002; Saleem and Syed, 2003). The informations regarding the interactive effect of nitrogen

and seed rate are lacking in Pakistan. Therefore, the present investigation was aimed to find out the forage yield at various seed rates and nitrogen levels and selecting the suitable combination of nitrogen levels and seed rate for higher forage yield with high quality under prevailing conditions of Faisalabad, Pakistan.

Materials and methods

The study regarding the effect of seeding rates of 30, 40 and 50 kg ha^{-1} and nitrogen levels viz. 0, 30 and 45 kg ha^{-1} on forage yield and quality parameters of cluster bean were carried out at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan (73.74° E, 30.31° N) during the year 2004. The factorial experiment was done by using randomized complete block design (RCBD) and the experiment was thrice replicated, using a net plot size of 1.8m x 6m. The crop was sown with single row hand drill on well prepared seed bed in 30 cm apart rows on last week of June. The full dose of phosphorus (60 kg ha^{-1}) and half of the prescribed level of nitrogen was incorporated in soil at time of seed bed preparation through single super phosphate and urea, respectively. The remaining half nitrogen was top dressed at time of first irrigation. All other cultural practices were kept normal and uniform for all plots. Data on different yield and quality parameters was recorded by using standard procedures. The plant morphological traits like, plant height, stem diameter and number. of branches per plant were recorded by randomly selecting ten plants from individual plot. The plant height was taken with measuring tape from ground to the highest leaf tip. The stem diameter was measured from bottom, middle and top portions with vernier caliper and then averages were taken. The fresh forage material was recorded by randomly harvesting three rows of 1m length from each plot and the value obtain was then converted hectare basis. The known weight of fresh mass was sun dried and shifted to electric oven at 70 ^{0}C for 72 hours. The dry matter % age against each treatment was used as tool to determine the total dry matter production. A sub sample of dry phytomass was grinded and stored in polythene bags for quality analysis. The quality parameters like crude fibre, crude protein and ash (% age) were determined by using methods described by AOAC (1984). The pooled data on various growth, yield and quality parameters were analyzed statistically using Fischer' s analysis of variance techniques and the treatments means were compared by using LSD test at 5 % probability level (Steel *et al*., 1997).

Results and discussion

Yield parameters and yield

Result showed that nitrogen had no role in improving the plant population as seen in Table 1. The results was quite in line to those of Ayub *et al*. (2002) and Zubair (2009) who reported non significant effect of nitrogen on plant density. The seed rate was significantly affected the plant population and it was increased by increasing seeding rates. The highest plant population (53.75 m^{-2}) was recorded with seed rate of 50 kg ha^{-1}. Since all treatments were sown with seed having almost same viability and 1000 grain weight, higher seed density was obtained at higher seed rates. An increase in plant population with increased seed rates that also reported by Ayub *et al.* (2002) and Ahmad *et al.,* (2004).

Table 1. Effect of different nitrogen levels and seed rates on yield and quality parameters.

Treatments Nitrogen (kg ha^{-1})	Plant Population (m^{-2})	Plant Height (cm)	Branches Per plant	Stem Diameter (cm)	Crude Protein (% age)	Crude Fibre (% age)	Ash (% age)
0	49.25	141.70 c	12.41 c	0.70 c	14.92 c	21.34 c	7.19 c
30	49.27	159.29 b	18.24 b	0.79 b	15.91 b	24.91 b	8.53 b
45	49.67	176.84 a	22.22 a	0.87 a	17.06 a	26.28 a	10.10 a
LSD	ns	6.48	0.55	0.013	0.19	0.26	0.41
Seed rate (kg ha^{-1})							
30	44.91 c	158.76	19.54 a	0.80	16.03	24.09	9.17 a
40	49.63 b	160.34	17.51 b	0.79	16.00	23.99	8.64 ab
50	53.75 a	158.75	15.28 c	0.78	15.85	23.73	8.02 b
LSD	2.41	6.48	0.55	0.013	ns	ns	0.41

Any two means not sharing the same letter in common differ significantly at 5 % probability.

The plant height responded positively to applied nitrogen and each increase in nitrogen levels significantly increased the plant height (Table 1). The tallest plants were obtained from plots given nitrogen at 45 kg ha^{-1}. The results are consistent to those of Abayomi *et al.* (2008) and Zubair (2009). They also reported a significant increase in plant height with increased rates of nitrogen. The plant height was not affected significantly by seed rates and maximum plant height (160.3 cm) was recorded at 40 kg seed ha^{-1}. The results were contradictory to those of Khan *et al.* (2000) who reported significant effect of seed rates on plant height of rice bean. The contradictory results might be due to variation in soil fertility status, climatic conditions or species differences.

The branching capacity of cluster bean can be improved by increasing nitrogen levels (Table 1). The maximum number of branches per plant were

obtained by giving nitrogen at 45 kg ha $^{-1}$. Significant increase in number of branches per plant by application of nitrogen was also reported by Anurag *et al*., (2002) and Zubair (2009). Increasing the seed rates decreased the number of branches. The reason for having less number of branches at higher seed rates may be due to more competition among plants for light, space and nutrients at higher seed rates. The highest branches per plant were observed at seed rate of 30 kg ha^{-1}. The results supported the findings of Biswas *et al.,* (1997) who observed inverse relationship between seed rate and number of branches per plant.

The stem diameter was increased with increase in nitrogen levels (Table 1) and the highest stem diameter was obtained when nitrogen was applied at 45 kg ha^{-1}. The results are supported by the findings of Suzuki *et al.,* (1991). However, the results were contradictory to those of Zubair (2009) who reported non significant increase in stem diameter with nitrogen application. The variations in soil fertility may be the cause of these contradictory results. The effect of seed rates on stem diameter was not significant.

The green forage yield is mainly controlled by plant population, plant height, stem diameter and number of branches per plant. The highest green forage yield (35.10 t ha^{-1}) was obtained with 45 kg N ha^{-1}. The increase in forage yield was mainly due to taller and thicker plants and more number of branches per plant. Increase in forage yield with nitrogen application was also reported by Sheikh *et al.,* (2004) and Modaihsh *et al.,* (2007). The forage yield was also increased with increase in seed rates and the increase was significant at each increased seeding rate. The highest yield was obtained a seeding rates of 50 kg ha^{-1}. The results confirmed the findings of Rajput and Singh (1996) who found a positive relationship between seed rate and fresh forage yield.

The dry matter yield was increased significantly with increase in nitrogen levels (Table 2). The highest dry matter yield was recorded with 45 kg N ha $^{-1}$. The increase in dry matter yield can be attributed to production of more dry matter as a result of improved photosynthetic activity at higher levels of nitrogen. The contradiction exists with findings of earlier workers like Sheikh (2004) and Modaihsh *et al*., (2007). The contradictory results may due to difference in genetic make up of the cultivar. Dry matter was significantly increased with increase in seeding rates. The highest dry matter yield was obtained with seeding rates of 50 kg ha^{-1}. This increase can be attributed to more plant population at given seed rates. Amissah-Arthur *et al*. (1999) reported that dry matter yield was increased with increase in seed rates.

Table 2. The effect of nitrogen levels and seed rates on green forage yield and dry matter yield of cluster bean.

Green forage yield (t ha $^{-1}$)					Dry matter yield (t ha $^{-1}$)				
Nitrogen (kg ha $^{-1}$)	Seed rates (kg ha $^{-1}$)				Nitrogen (kg ha $^{-1}$)	Seed rates (kg ha $^{-1}$)			
	S1	S2	S3	Mean		S1	S2	S3	Mean
N1	25.50 i	26.64 h	28.18 g	29.69 c	N1	6.06 h	6.29 g	6.70 g	6.36 c
N2	30.51 g	31.56 e	32.47 d	30.96 b	N2	7.26 e	7.51 d	7.30 c	7.50 b
N3	33.05 c	34.87 b	37.38 a	32.67 a	N3	7.87 c	8.30 b	8.90 a	8.36 a
Means LSD= 0.27	26.71 c	LSD= 0.47 31.56 b	35.10 a		Means LSD= 0.063	7.06 c	LSD=0.11 7.37 b	7.78 a	

*Any two means not sharing the same letter in common differ significantly at 5 % probability.

Quality parameters

Crude protein contents were significantly increased with increasing the nitrogen rates (Table 1). The maximum crude protein contents were obtained when nitrogen was applied at 45 kg ha $^{-1}$. The higher crude protein at higher nitrogen levels was mainly due to structural role of nitrogen in building up amino acids. The progressive increase in crude protein contents with increasing nitrogen rates were also reported by Kumawat *et al*., (2000), Sheikh *et al.,* (2004), Morshed *et al*., (2008) and Ibrahim (2009). The effect of seed rate on crude protein was not significant and it ranged between 15.85 to 16.03 %.

Each increase in nitrogen level significantly increased the crude fibre contents (Table 1) and the maximum crude fibre contents were obtained from plots given nitrogen at 45 kg ha^{-1}. The results are consistent to those of Sheikh (2004), Iqbal *et al*., (1998) and Ayub *et al*., (2007) who also reported higher crude protein contents at higher nitrogen rates. The seed rates were non significant effect on crude fibre contents but decreasing trend with increased seed rates. Decrease in crude fibre contents with increased seed rates were also reported by Ayub *et al.,* (2002). The maximum and minimum crude fibre contents were obtained at seeding rates of 30 and 50 kg ha^{-1}, respectively. The non significant effect of seed rates on crude fibre contents reported by Anonymous (2000) and Ayub *et al*. (2007).

Each increase in nitrogen rate significantly increased the ash contents (Table 1) and the maximum ash contents were obtained with application of 45 kg N ha $^{-1}$. The significant increase in ash contents with nitrogen application reported by Iqbal *et al.,* (1998) and Ibrahim (2009). Ash contents were decreased with increase in seed rate. The plot sown at 50 kg ha $^{-1}$ produced significantly lower ash contents than plots sown at seed rate of 30 kg ha^{-1}. The difference between seed rates of 40 and 50 kg ha $^{-1}$ was not significant. Decrease in ash contents with increase in seed rates was reported by Ayub *et al*., (2007).

Interactive effect

The interactive effect of nitrogen and seed rates was not significant on all recorded parameters except green and dry matter yield (Table 2). The lowest green forage and dry matter yield was obtained with lowest seed rate 30 kg ha^{-1} and without nitrogen application. The highest green forage and dry matter yield was obtained at seed rate of 50 kg ha^{-1} with nitrogen application at 45 kg ha^{-1}.

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References

Abayomi, Y.A., Ajibade, T.V., Sammuel, O.F. and Saadudeen, B.F. (2008). Growth and yield responses of cowpea (*Vigna unguiculata* (L) Walp) genotypes to nitrogen fertilizer (NPK) application in the Southern Guinea Savanna Zone of Nigeria. Asian J. Plant Sci. 7:170-176.

Ahmad, R., Mahmood, I., Kamal, J. and Bukhari, S.A.H. (2004). Growth and yield response of three mungbean (*Vigna radiate* L.) cultivars to varying seeding rates. Int. J. Agric. Bio. 3: 538–540.

Akter, S., Farid, A.T.M., Shil, N.C. and Rahman, M. (1998). Effect of different fertilizers on nodulation and yield of Cowpea. Legume Res 21: 74-78.

Amissah-Arthur, A.A., Jagtap, S.S. and Dashiell, K.E. (1999). Plant density effects on growth and yield of tropical Soybean. Trop. Sci 39: 162-167.

Anonymous. (2002). Annual report. Fodder Research Institue, Sargodha, Pakistan, pp: 15-18.

Anonymous. (2003). Annual Report. Fodder Research Institute, Sargodha, pp: 7.

Anonymous.(2000). Annual Report, Fodder Research Institute, Sargodha, Pakistan, pp: 13-17.

Anurag, S., Singh, Y.V., Singh, D.V. and Patidar, M. (2002). Effect of nitrogen, phosphorus and sulphur on growth and yield of cluster bean. In proceedings of national symposium on arid legumes for food nutrition security and promotion of trade, Hisar, India, 15-16 May, 2002. [Field Crop Absts., 56(11): 8402;2003].

AOAC. 1984. Official methods of analysis. Association of Official Agriculture Chemists. 14 th ed. Arlington, Virginia, USA, 1984.

Ayub, M., Nadeem, M. A., Tanvir, A., Tahir, M. and Khan, R. M. A. (2007). Interactive effect of different nitrogen levels and seeding rates on fodder yield and quality of pearl millet. Pak. J. Agri. Sci. 44: 592-596.

Ayub, M., Tanveer, M.A., Ali, S. and Nadeem, M.A. (2002). Effect of different nitrogen levels and seed rates on growth, yield and quality of Sorghum (*Sorghum bicolor* L.) fodder. Ind. J. Agri. Sci.72: 648-650.

Baboo, R., and Mishra, S.K. (2001). Growth and pod production of cow pea (*Vigna sinensis* Savi.) as influenced by inoculation, nitrogen and phosphorus. Annuals of Agri. Res. 22: 104-106.

Biswas, P.K., Akhteruzzaman, M., Sutradhar, G.N.C. and Biswas, K.K. (1997). Effect of seed rates on grain yield and yield attributes of cow pea. Bangladesh J. Sci. Ind. Res. 32: 333-335.

GOP. (2010). Economic survey of Pakistan, 2009-10. Economic Advisor's Wing, Finance Division, Islamabad, Pakistan.

Ibrahim, M. 2009. Determination of forage production potential of maize sown as a mixture with different legumes under different nitrogen application. P.hd. Thesis, Dept. Agron., Univ. Agric. Faisalabad, Pakistan.

Iqbal, K., Tanveer, A. Ali, A., Ayub, M. and Tahir, M. (1998). Growth and yield response of rice bean fodder to different levels of N and P. Pak. J. Bio. Sci. 1:212-214.
Khan, H., Malik, M. A., Saleem, M. F., Cheema, M. A. and Ahmad, A. (2000). Effect of different seeding times and seed rates on the growth yield and quality of rice bean. Int. J. Agri. Biol. 1: 104–106.
Kumawat, S. M., Dhakar, L. L., and Maliwal, P. L. (2000). Effect of irrigation regimes and nitrogen on yield, oil content and nutrient uptake of soybean (*Glycine max* L.). Indian J. Agron. 45: 361-366.
Lone, B. A., Badr-ul-Hassan, Ansar-ul-Haq, S. and Khan, M. H. (2010). Effect of seed rate, row spacing and fertility levels on relative economics of soybean (*Glycine max* L.) under temperate conditions. Afric. J. Agric. Res. 5: 322-324.
Marton, L., and Kadar, I. (1998). Effect of nitrogen supplies on yield components of Soya. A nitrogenellats hatasa a szoja terneselemeire, Novenytermeles 47: 677-687.
Modaihsh, A.S., Taha, A.A. and Mahjoub, M.O. (2007). Effect of phosphorus and nitrogen fertilization and irrigation intervals on guar crop under calcarious soil. J. Agric. Sci. Mansoura Uni. 31: 4031-4039.
Morshed, R. M., Rahman, M. M. and Rahman, M. A. (2008). Effect of nitrogen on seed yield, protein content and nutrient uptake of soybean (*Glycine max* L.). J Agric Rural Dev., 6: 13-17.
Osborne, S.L., and Riedell, W.E. (2006). Starter nitrogen fertilizer impact on soybean yield and quality in Northern Great Plains. Agron. J. 98:1569-1574.
Rad, S.F., Mazaheri, D. and Banah, T. (1999). Effect of planting dates and plant density on yield and growth of cowpea line 29005. Seed and Plant 15(2): 84-89.
Rajput, A.L., and Singh, T.P. (1996). Response of nitrogen and phosphorus application with and without inoculation on fodder production of Cow Pea (*Vigna unguiculata* L.). Ind. J. Agron. 41: 91-94.
Saleem, M.A., and Syed, A.A.S. (2003). Guar ke jaded kasht. Zarat Nama, 15 April, 2003: pp: 202-204.
Sharma, H., Nahatkar, S. and Patel, M.M. (1996). Constraints of soybean production in Madhya Pradesh-an-analysis. Bhartiya Krishi Anusandhan Patrika. 11: 79-84.
Sheikh, A.A. (2004). Effect of irrigation intervals, nitrogen and phosphorus application on forage yield, carbohydrates and protein contents of guar in the central region of Saudi Arabia. Saudi J. Bio. Sci. 11(1): 3-9.
Steel, R.G.D., Torrie, J.H. and Dickey, D.A. (1997). Principles and Procedures of Statistics, a biometrical approach. 3rd Ed. McGraw Hill, Inc. Book Co. N, Y., pp: 352-358.
Suzuki, M., Miyakawa, H. and Sato,Y. (1991). Measures against decreasing yield in continuously cropped Soybean. 8. The effect of ploughing in green Barley for increased Soybean yield and the effect of basal nitrogen applied to Soybean with soiling Barley. The Crop Sci. Soc. Japan 34: 65 [Soybean Absts. 17(3): 1219; 1994].
Taiz, L., and Zeiger, E. (2006). Plant physiology; 4th ed., Sinauer Associates, Inc; pubisher. pp: 79.
Undersander, D. J., Putnam, D. H., Kaminski, A. R., Kelling, K. A. and Doll, J. D. (2006). University of Wisconsin-Madison. www.hort.purdue.edu/ newcrop/
Zubair, M.A. (2009). Effect of different applications of nitrogen on growth, forage yield and quality of three cluster bean cultivars. MSc. Thesis, Dept. Agron., Univ. Agric. Faisalabad, Pakistan.

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