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Research Article

Response of Different Doses of Nitrogen on Broccoli (*Brassica oleracea var. italica*) in Lamjung District

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Abstract

The study was carried out to examine the optimum dose of Nitrogen on Broccoli in Institute of Agriculture and Animal Science, Lamjung Campus during Sept, 2015- Jan, 2016. Six treatment Viz. 50, 100,150,200, 250, 300 kg/ha of Nitrogen with same level of P and k (160:100 kg/ha) and FYM (20 t/ha) were used in a Randomized Complete Block Design with three replications. Effect of treatments on plant height, leaf area and head weight plant^{-1}, yield ha^{-1} were significant and other parameters (leaf number, SPAD reading, plant spreading) were not affected by the treatments. Treatment that received 300 kg N ha^{-1} gave the maximum yield ha^{-1} (14.77 ton) which was followed by treatment that received 250 kg N ha^{-1} (10.60 ton), 200 kg N ha^{-1} (8.11 ton), 150 kg N ha^{-1} (7.432 ton), 100 kg N ha^{-1} (5.96 ton) and 50 kg ha^{-1} (4.24 ton). Treatments 250 kg N ha^{-1}, 200 kg N ha^{-1}, 150 kg N ha^{-1} and 100 kg N ha^{-1} were statistically at par while 50 kg produced the least yield ha^{-1}. Application of 300 kg N ha^{-1} gave the higher result with respect to plant height (17.75 cm), leaf area (699.32 cm^2), leaf number (7.77), SPAD reading (68.71), plant spreading (70.21 cm), compared to other treatments while minimum result obtained from application of 50 kg N ha^{-1}. Hence, we can conclude that the total head production increased with increased N rate application in broccoli, but the optimum level of N could be beyond 300 Kg ha^{-1}, which needs further experimentation.

Keywords: Broccoli; Head; Nitrogen; Yield

Introduction

Broccoli (*Brassica oleracea* L.) is a cool season vegetable, fall under the Cruciferae (Brassicaceae) family. It is a comparatively newer winter vegetable crop in Nepal (Ghimire *et al.,* 1993). Among the cole crops, it has the highest nutritive and good commercial value (Yoldas *et al.*, 2008). In Lamjung district, broccoli production area was 25 ha with the production and productivity 273 Mt and 11 Mt/ha respectively (MOAD, 2013/14). But the production of the broccoli is mainly limited to home consumption only. However, commercial cultivation of broccoli has started in recent years in mid hill regions of Lamjung district with limited governmental support. For commercial cultivation, it is important to determine fertilizer (including N) requirement of broccoli varieties. It removes large amount of macro nutrient from the soil because of its heavy feeding nature (Purewal, 1975). Nitrogen is an essential plant nutrient, which has a crucial role in growth and developments of crops. Although role and importance of nitrogen fertilizer in crop cultivation is reported very frequently, nitrogen fertilizer requirement of broccoli cultivated in Lamjung district of Nepal is not documented

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yet. Moreover, Nepal is very diverse in topography, climate, soil and this make the blanket recommendation does not suitable for growing of any vegetables. We, therefore, conducted a field experiment with the objective to determine optimum rate of N fertilizer for effective growth and yield of broccoli in Lamjung district of Nepal.

Methodology

The field experiment was conducted at horticulture farm of Institute of Agriculture and Animal Sciences, Lamjung campus, Lamjung during a growing season of broccoli (Sept, 2015 – Jan, 2016). The district (Latitude: 28º03'19" to 28º30'38" N and Longitude: 84º11'23" to 84º38'10" E) covers an area of 1692 sq.km with an altitude range from 385 m to 8162 m. The climate of the study area is subtropical type that receives average annual precipitation of 2944.23mm with rainfall from June – September. Sub–humid type of weather condition with cold winter, hot summer and distinct rainy season. The experiment was carried out in a single factorial randomized complete block design (RCBD) with six rates of N (50, 100, 150, 200, 250, 300 kg/ha which are referred to as T_1, T_2, T_3, T_4, T_5, and T_6 respectively) and 3 replications in each treatment combination. The individual plot size was 3 × 1.8 m^2. There were 5 rows in each plot and 4 plants in each row with row to row distance of 60 cm and plant to plant distance of 45 cm. Raised nursery beds were prepared where seeds were sown on 9th September 2015. Uniform sized seedlings with 3 - 4 leaves were selected and transplanted in the prepared experimental plots on 9th October 2015. The experimental plots were well prepared by ploughed one time with cultivator and made pulverized with the help of spade. Weeds and debris were removed manually. Farmyard manure (FYM) @ 20 t ha^{-1} was well mixed at equal amount in each plot before transplanting. BesidesFYM, all the plots were fertilized with 160 kg ha^{-1} phosphorus (P) and 100 kg ha^{-1} potassium (K) through Di-ammonium phosphate (DAP) and Muriate of potash (MOP), respectively. Half dose of N fertilizer was applied in the form of urea in all plots. Half dose of N and full doses of P, K were used as basal dose at the time of transplanting. A light irrigation was given after transplanting of the seedlings. General intercultural operations and plant protection measures were followed as per requirement of the plants. First weeding and side dressing with 1/4 amount of N was done at 25 days after transplanting (DAT) while remaining 1/4 amount of N, weeding and earthing up was done at 50 DAT i.e. before curd initiation stage. Micronutrients such as Borax and Vitavex were applied at time of curd initiation. Irrigation was given as and when needed. Measurements were taken from inner 6 plants while the remaining 14 plants were considered as border plants. Three plants were randomly selected as sample plants from those six plants. The measurements taken were plant height, number of leaves, leaf area, SPAD reading, plant spreading and weight of head $plant^{-1}$, Net-plot yield and yield ha^{-1}. Regarding to software program, MS-word 2013 used for word processing, MS-excel 2013 used for tabulation and SPSS 16.0 used for statistical analysis. ANOVA was done to test the significance of difference for each parameter. Means were separated with Tukey Test at 5% level of significance.

Results and Discussion

Plant Height

The difference in plant height due to various levels of N was found significant. The treatment that received 300 kg Nha^{-1} gave the highest plant height (17.78cm) which was followed by 250 kg N ha^{-1}, 200 kg N ha^{-1} and 150 kg N ha^{-1} and least was produced by 50 kg N ha^{-1} (14.2cm) (Table 1). Nitrogen compounds comprise 40% to 50% of the dry matter of protoplasm, and it is a constituent of amino acids, nucleicacidand the building blocks of proteins (Swan, 1971; Mengel and Kirkby, 1987). Being one of the important nutrients with its role in plant metabolism and development, its application boosts plant growth (Neethu *et al*, 2015). Similar findings were also reported by Giri *et al.* (2013) and Neethu *et al.* (2015).

Leaf Number

Effect of different doses of N on leaf number of broccoli plant was found non-significant. However, the treatment that received 300 kg N ha^{-1} produced the higher number of leaves per plant (8) and the least leaf number (6) was produced by the treatment that received 50 kg N ha^{-1} (Table 1). Nitrogen is the mineral nutrient that boosts plant growth and development. It is said that N is responsible for the vegetative growth of broccoli plants (Neethu *et al.,* 2015).

Leaf Area

The results summarized in the Table 1 revealed that leaf area of broccoli plant increased significantly with the application of successive doses of nitrogen. Treatment that received 300 kg N ha^{-1} had the maximum leaf area (699.32 cm^2) which is statistically at par with treatments that received 250, 200, 150 kg N ha^{-1} respectively. The lowest leaf area (512.19 cm^2) is produced by the crop that received 50 kg N ha^{-1}. Higher doses of N enhanced the leaf area due to the fact that nitrogen helps in growth of plants (Neethu *et al.,* 2015). When the supply of Nitrogen to the roots increases, the synthesis of cytokinin is increases and ultimately more transfer of cytokinin is transfer to leaves for their growth and expansion (van der Werf and Nagel, 1996). Agarkar *et al.* (2009) reported the same results.

Table 1: Response of different doses of N on plant height, leaf number, leaf area, SPAD reading and plant spreading, average weight of head, Net-plot yield and yield ha^{-1} of broccoli in IAAS, Lamjung campus, 2015/16

Treatments Nitrogen	Plant height (cm)	Leaf number	Leaf area (cm^2)	SPAD reading	Plant spreading (cm)	Weight of head (g)	Net-plot yield (kg)	Yield ha^{-1} (ton)
50 kg N/ha	14.2^{c}	6.66	512.19^{c}	63.71	59.61	114.72^{d}	0.688^{d}	4.24^{d}
100 kg N/ha	15.1^{bc}	6.77	574.49^{bc}	64.31	59.61	160.97^{cd}	0.965^{cd}	5.96^{cd}
150 kg N/ha	15.71^{abc}	6.88	645.56^{ab}	64.76	62.93	200.68^{bcd}	1.204^{bcd}	7.43^{bcd}
200 kg N/ha	16.21^{abc}	7.10	649.44^{ab}	65.04	63.59	219.15^{bc}	1.314^{bc}	8.11^{bc}
250 kg N/ha	17.22^{ab}	7.55	673.72^{ab}	65.72	68.16	286.27^{b}	1.717^{b}	10.60^{b}
300 kg N/ha	17.78^{a}	7.77	699.32^{a}	68.71	70.21	398.82^{a}	2.392^{a}	14.77^{a}
Significance	*(0.05)	(0.481) NS	*(0.02)	(0.46) NS	(0.65) NS	**(0.00)	**(0.00)	**(0.00)

Means in column followed by similar letter/s are not significantly different
* = significant at 5% level of significance, ** = significant at 1% level of significance, NS = Non- significant

SPAD Reading

The results in the Table 1 showed that the SPAD reading at different doses of N was found non-significant. However, treatment that received 300 kg N ha^{-1} gave the higher SPAD reading (68.71) while the minimum (63.71) was given by treatment that received 50 kg N/ha. Nitrogen is the main structural compounds of the chlorophyll ($C_{55}H_{70}O_6N_4Mg$) and constituents of all amino acids in protein and lipids that involves in the photosynthesis molecules like RuBP carboxylase (Rubisco) and light harvesting complex (Evans, 1989a). The enzyme Rubisco determines the rate of CO_2 assimilation, and thus the photosynthetic rate (Evans, 1989b). Thereafter, affects formation of chloroplast and accumulation of chlorophyll in them.

Plant Spreading

Effect of different doses of N on plant spreading of broccoli was found non-significant as shown in Table 1. However, the larger plant spreading (70.21 cm) produced by the treatment that received 300 kg N ha^{-1} and smaller plant spreading (58.19 cm) produced by the treatment that received 50 kg N ha^{-1}. The increase in vegetative growth, leaf length, leaf breath, leaf area under different treatments can be attributed to the increase in plant spread (Kumar *et al.*, 2013).

Weight of Head

The results in the Table 1 showed clearly that the response of different level of N on head weight of broccoli was found highly significant i.e. with increasing the dose of N, the average head weight of broccoli also get increased. The treatment that received 300 kg N ha^{-1} gave the highest head weight $plant^{-1}$ (398.82 g) which is followed by treatment with 250 kg N ha^{-1} (286.27 g) and least head weight $plant^{-1}$ (114.72 g) was produced by the treatment that received 50 kg N ha^{-1}. Thakur *et al.* (1991) reported that higher N level increased the dry matter production and accumulation. It is due to proper utilization of carbohydrates, proteins and photosynthetic accumulation and performs many functions like carbohydrate metabolism, enzyme activation and translocation of sugars and starch to the storage organ i.e. head. Similar results were found by Singh *et al.* (2015), Sahah *et al.* (2010), Giri *et al.* (2013) etc.

Net-plot Yield

Effect of different doses of N on net-plot yield of broccoli was found highly significant as shown in Table 1. Highest net plot yield (2.392 kg) was obtained from the treatment that received 300 kg N ha^{-1} which is followed by the treatment 250 kg N ha^{-1} (1.717 kg) and least net plot yield (0.688 kg) was produced from the treatment that received 50 kg N ha^{-1}. Nitrogen is necessary for enzymatic reactions in plants since all plant enzymes are proteins. It might be due to the reason that with increasing application of N, vegetative growth and metabolism increases that leads to increase in leaf number, leaf area, chlorophyll content which ultimately increases the photosynthesis rate and synthesis of dry matter i.e. carbohydrates, proteins, sugar etc. Sahah *et al*. (2010) and Giri *et al*. (2013) found the similar results.

Yield Ha^{-1}

The results in the Table 1 showed that the yield ha^{-1} of broccoli at different doses of N was found highly significant. The treatment that received the 300 kg N ha^{-1} produced the highest yield ha^{-1} (14.77 tons) which is followed by the treatment 250 kg N ha^{-1} (10.60 tons) and least yield ha^{-1} (4.24 tons) was produced from the treatment that received 50 kg N ha^{-1}. It might be due to increased in all the above mention parameters that attribute to increase the final yield ha^{-1} which is due to more vegetative growth, development, photosynthesis, dry matter synthesis and translocation to storage organ. It might be due to the optimum accumulation of N and translocation of micronutrient such as boron and thus yield from the crops get increases. Similar results were found by Supe and Marbhal (2008); Singh *et al.* (2015) etc.

Conclusion

The aim of the current study was to optimize nitrogen nutrition of broccoli cultivated at Lamjung, Nepal. Total curd production increased with increased N rate in broccoli reaching a maximum of 14.77 t ha^{-1} at N rate of 300 kg ha^{-1}. Increase in total yields from high rates of N were obtained only when an adequate rate of P and micronutrients such as boron was applied. Hence, above results indicated that optimum level of N could be beyond 300 kg ha^{-1}, which needs further experimentation.

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