Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 1371-1373
Received: 07-05-2020
Accepted: 09-06-2020

Daljeet Singh
Department of Agronomy, College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India

Ajmer Singh Sidhu
Department of Agronomy, College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India

Balwinder Singh Dhillon
Department of Agronomy, College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India

Corresponding Author:
Balwinder Singh Dhillon
Department of Agronomy, College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India

Growth and yield of basmati rice (*Oryza sativa)* cultivars as influenced by nitrogen application

Daljeet Singh, Ajmer Singh Sidhu and Balwinder Singh Dhillon

Abstract
The field experiment entitled "Growth and yield of basmati rice (*Oryza sativa* L.) cultivars as influenced by nitrogen application" was conducted at Guru Kashi University, Bathinda during *kharif* season of 2015. The experiment comprised of 4 levels of N and 2 varieties of basmati rice in split plot design replicated four times. Nitrogen was applied in three equal splits (0, 21, 42 days after transplanting at rates of 0, 40, 60 and 80 kg ha^{-1} in Pusa Basmati 1121 and Pusa Basmati 1509. Maximum grain yield was obtained in Pusa Basmati 1509 (59.1 q ha^{-1}) and Pusa Basmati 1121 (51.7 q ha^{-1}) with application of 80 kg N ha^{-1}. The lowest grain yield was (30.8 q ha^{-1}) in Pusa Basmati 1121 and Pusa Bamati 1509 (32.5 q ha^{-1}) in the no N plots. With increase in N rate, grain yield was increased upto 80 kg N ha^{-1} in both the varieties. At all N rates, grain yield was more in Pusa Basmati 1509 than Pusa Basmati 1121. So, it can be concluded that 80 kg ha^{-1} of N application is optimum for achieving potential yield of basmati rice.

Keywords: Basmati rice, grain yield, nitrogen, variety

Introduction
Rice (*Oryza sativa* L.) is principal food crop of South India and South Eastern countries and supports nearly one half of the world population. It, being the staple food for more than two third of the Indian population, holds the key for food security and plays a pivotal role in national economy. Basmati occupies a prime position in Indian culture, not only for its superior organoleptic qualities, but also as an auspicious food. India had an immense wealth of aromatic rice, much of which has been lost during the last three decades in the aftermath of the Green Revolution, where emphasis was on yield rather than quality. Basmati (bas means aroma, mati means queen) is popular not only throughout Asia but also in Europe and the United States. Basmati rice is traditionally associated with Himalayan foothills with India and Pakistan producing 70 and 30 per cent respectively, of the total Basmati rice of the world (Bligh 2000) [2]. Upon cooking/ cooked Basmati rice is characterized by extra-long, super-fine, slender grains with chalky endosperm and a shape comparable with a Turkish dagger; pleasant and exquisite aroma, sweet taste, dry and soft texture, delicate curvature; medium to low gelatinization temperature and one and a half to two-fold length-wise elongation, with least breadth-wise expansion and tenderness (Siddiq *et al.* 1997) [11].

Basmati rice responds differently to N application as compared to non-basmati rice. Most of the basmati rice cultivars are susceptible to disease and insect-pest attack, and more prone to lodging. Therefore, nitrogen requirement of basmati rice is quite low and excessive use of N adversely affects the crop yield. To achieve high yield and to improve quality, N is a major factor considered in all types of environment. Low N may not lead to realization of maximum yield potential and high N may lead to lodging, increased incidence of insect pest attack and lower quality. One major consequence of inadequate N is reduced leaf area, thereby, limiting light interception, photosynthesis and finally biomass growth, grain yield and water productivity (Sinclair 1990). In last decade, IARI New Delhi has developed and released basmati type varieties such as Pusa Basmati 1121 and Pusa Basmati 1509. These varieties have also been released and recommended by PAU Ludhiana for Punjab state as Pusa Basmati 1121 and Pusa Basmati 1509. These varieties have quite high yield as compared to tradional basmati varieties. It is quite obvious to achieve full yield potential of these varieties, nitrogen requirement may be greater than traditional basmati varieties. Therefore, it is necessary to know the optimum rate of N application, as well as its influence on components of yield and growth parameters of high yielding basmati varieties. Keeping these facts/observations in view, present experiment entitled Influence of nitrogen application on the yield and yield parameters of different cultivars of basmati rice was conducted.

Material and Methods

An account of location, climate during crop season, materials used, methodology and techniques adopted in conducting the present investigation entitled "Influence of nitrogen application on yield and yield parameters of different cultivars of basmati rice *(Oryza sativa* L.)" was carried out in experimental area of research farm of Guru Kashi University, Talwandi Sabo (Bathinda) during Kharif 2015-16.Talwandi Sabo is located at $29^0$57'N latitude and 75^0 7'E longitude and altitude of 213 meters above the sea level. This tract is characterized by semi arid climate, where both winters and summers are extreme. A maximum temperature of about 45-48^0C is not uncommon during summer, while freezing temperature accompanied by frost occurrence may be witnessed in the months of December and January. The monsoon generally starts in the first week of July. The mean annual rainfall fluctuates around 500 mm, the major part of which is during the months of July to November with the few showers of cyclonic rains during winter months. A composite soil sample (0-15 cm) was collected from experimental field before planting of crop. The soil sample was air dried, grinded, and sieved to study the physicochemical properties of experimental field. The soil of experimental field was loamy sand in texture. The soil was netural (pH 7.4) and with normal electrical conductivity (0.26 dSm-1). The soil was low in organic carbon (0.32%) and available nitrogen (125 kg/ha), medium in available phosphorus (13.9 kg/ha) and available potassium (245.6 kg/ha). The experiment was laid out in split plot design with two basmati varieties i.e. Pusa basmati 1121 and Pusa basmati 1509 in main plots and four nitrogen levels (0 kg/ha, 40 kg/ha, 60kg/ha and 80 kg/ha and 3 equal splits 0, 21, 42 Day After Transplanting) in sub plots, replicated four time. All the observations growth and yield of basmati rice (*Oryza sativa* L.) cultivars were recorded at 28 DAS, 56 DAS, 84 DAS and harvesting time. The collected data were statistically analyzed by using Fisher's ANOVA technique and least significant difference (LSD) test at 5% probability level was used to compare differences among treatment means.

Results and Discussion

Growth attributes

Plant height of Pusa Basmati 1121 (111.1cm) was significantly higher than Pusa Basmati 1509 (94.7 cm) at all levels of nitrogen at harvesting time. It indicates that Pusa Basmati 1509 is genetically dwarf variety than Pusa Basmati 1121.It indicates that nitrogen application upto 80 kg ha^{-1} increased the plant height significantly in both the varieties at harvesting time. The increase in plant height in response to increased N application might have been caused by enhanced vegetative growth resulting from increase in cell size and meristematic activity. Similar results were reported by Kumar and Mahajan (2014) [9] who observed that plant height increase with increasing nitrogen levels. Dry matter accumulation was significantly increased by increased application of nitrogen rate upto 80 kg N ha^{-1} at all growth stages in both the varieties. The dry matter production was more in Pusa Basmati 1509 (138.6 q/ha) as compared to Pusa Basmati 1121 (129.3 q/ha) at all nitrogen levels. The maximum dry matter accumulation was observed at 80 kg N ha^{-1} in both the varieties at all growth stages. These results are in conformity with findings of Mannan *et al.* (2010) [10] who reported that in basmati rice, 75 kg ha^{-1} of N produced significantly higher DMA by the crop than 25 and 50 kg ha^{-1} of N application. Gautam *et al.* (2008) [6] also reported that each successive increase in N rate significantly increased the DMA by the crop at different growth stages.

Table 1: Effect of nitrogen levels on the growth parameters of both cultivars of basmati rice

Treatment	Plant height (cm)	Dry matter accumulation (q/ha)
Nitrogen levels (Kg/ha)		
0	86.9	90.2
40	101.2	119.6
60	109.0	159.3
80	116.1	166.7
LSD (p = 0.05)	2.1	0.7
Basmati cultivars		
Pusa basmati 1121	111.9	129.3
Pusa basmati 1509	94.7	138.6
LSD (p = 0.05)	0.2	0.9

Yield attributes

The grain yield of basmati rice was significantly influenced by rate of N application and varieties (Table 2). The significant increase of grain yield with increased rate of N application upto 80 kg N ha^{-1} was observed in both the varieties. However Pusa Basmati 1509 (48.1q/ha) gave significantly higher grain yield than Pusa Basmati 1121 (43.9 q/ha) at all the levels of N application. The percent increase in grain yield with increase in N rate from 0 to 80 kg N ha^{-1} was 20.9 percent and 26.6 percent in Pusa Basmati 1121 and Pusa Basmati 1509 respectively. Hasegawa (2003) [8] reported that grain yield can be increased by increasing total dry matter production of the crop. In another study, Fageria (2007) [4] reported that N fertilization significantly increased tillering of rice crop, which was further correlated to grain yield. Since N compounds make up a significant part of total weight of plants, increase in N application ultimately leads to increase in plant growth. The significant increase of straw yield with increased rate of N application upto 80 kg N ha^{-1} was observed in both the varieties. However Pusa Basmati 1509 (102.6 q/ha) gave significantly higher straw yield than Pusa Basmati 1121 (93.0 q/ha) at all the levels of N application. Mannan *et al.* (2010) [1] and Awan *et al.* (2011) [1] also reported increase in straw yield of rice with N rate. The harvest index (HI) expressed as percentage determines the proportion of economical yield (grain yield) to total biological yield (Fageria 2009) [5]. The harvest index was not affected by nitrogen levels and varieties. In both the varieties, HI was almost similar (Table 2). Similarly effect of nitrogen levels on HI was also not significant. Similar results were observed by Gunri *et al.* (2004) [7] who reported that increase in N rates did not cause any improvement in harvest index.

Table 2: Effect of nitrogen levels on the yield attributes of both cultivars of basmati rice.

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)
Nitrogen levels (kg/ha)			
0	31.7	64.9	32.7
40	45.3	96.6	31.8
60	51.5	108.9	32.0
80	55.4	120.7	31.4
LSD (p = 0.05)	2.1	1.5	NS
Basmati Cultivars			
Pusa basmati 1121	43.9	93.0	32.0
Pusa basmati 1509	48.1	102.6	31.9
LSD (p = 0.05)	0.9	1.6	NS

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