



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2020; 8(1): 980-984

© 2020 IJCS

Received: 07-11-2019

Accepted: 09-12-2019

**Saba Shafai**

Sher-e-Kashmir University of  
Agricultural Sciences and  
Technology of Kashmir, Jammu  
Kashmir, India

**Raihana Habib Kanth**

Sher-e-Kashmir University of  
Agricultural Sciences and  
Technology of Kashmir, Jammu  
Kashmir, India

**Bashir Ahmad Alie**

Sher-e-Kashmir University of  
Agricultural Sciences and  
Technology of Kashmir, Jammu  
Kashmir, India

**Ahmad Abdullah Saad**

Sher-e-Kashmir University of  
Agricultural Sciences and  
Technology of Kashmir, Jammu  
Kashmir, India

**Showkat Maqbool**

Sher-e-Kashmir University of  
Agricultural Sciences and  
Technology of Kashmir, Jammu  
Kashmir, India

**Shaista Nazir**

Sher-e-Kashmir University of  
Agricultural Sciences and  
Technology of Kashmir, Jammu  
Kashmir, India

**Corresponding Author:****Saba Shafai**

Sher-e-Kashmir University of  
Agricultural Sciences and  
Technology of Kashmir, Jammu  
Kashmir, India

## Behaviour of popcorn (*Zea mays Everta*) under different nitrogen regimes in the rainfed conditions of valley

**Saba Shafai, Raihana Habib Kanth, Bashir Ahmad Alie, Ahmad Abdullah Saad, Showkat Maqbool and Shaista Nazir**

DOI: <https://doi.org/10.22271/chemi.2020.v8.i1m.8373>

### Abstract

Two field experiments were conducted at DARS Budgam, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during 2016 and 2017 under rainfed conditions with the objective to study the growth and yield of popcorn at different nitrogen levels. Experiment was laid in split-split plot design assigning three Sowing Dates 19<sup>th</sup> Standard Metrological week (May 02-May 08) (D<sub>1</sub>), 21<sup>th</sup> Standard Metrological week (May 16-May 22) and 23<sup>rd</sup> Standard Metrological week (May 30-June 05). Three nitrogen levels viz: N<sub>1</sub>=90 kg ha<sup>-1</sup> N<sub>2</sub>=120 kg ha<sup>-1</sup> and N<sub>3</sub>=150 kg ha<sup>-1</sup>. The results revealed that nitrogen levels influences growth characters like plant height, total number of leaves per plant, dry matter accumulation increased significantly with 120kg/ha nitrogen. Also grain and stover yield showed significant and consistent improvement with increased dose of nitrogen (120 kg/ha). Yield attributing characters showed significant improvement with increasing the level at 150kg/ha. Also popping percentage and nutrient content of plant at anthesis and grain was significantly higher for 150kg/ha nitrogen whereas popping volume and nitrogen content in stover was statistically at par with respect to three nitrogen levels.

**Keywords:** Nitrogen content, nitrogen uptake, popping percentage, popping volume, yield attributes, yield

### Introduction

Popcorn (*Zea mays* var. *everta*) is type of corn grown in small acreage around the urban area. The ability to pop is the unique characteristic that distinguishes from other types of corn. The grains of popcorn are small pointed with honey or hard endosperm. The endosperm has more hard starch compared to soft starch. The difference in popping character of dent corn and popcorn is that, relatively higher soft endosperm of the dent or flour corn with fragile cell walls allow the steam generated during the application of heat to leak out before enough pressure is generated to cause an explosion. But in popcorn with more of hard endosperm, the starch granules are so embedded in tough elastic colloidal material that confines and restricts to steam pressure generated within the granule on heating until it reaches explosive force (Weatherwax, 1922) [15]. Thus when the kernels of popcorn heated the pressure built up within kernel resulted in an explosion and the grain turned inside out.

Now-a-days corn grain is also a key raw material used for producing starch, glucose and oil. Corn starch is used to make sweeteners, as well as such items as disposable forks and spoons. Corn starch is widely used for industrial purposes such as coating for paper and paper products and wallboards for buildings. The pharmaceutical industry also uses corn starch to make pills and other similar products. Recently, high fructose corn syrup has also been made from corn starch. This is mostly used in manufacture of coke and other drinks. In some countries, alcohol made from corn is blended in fuel for gasoline-powered vehicles to reduce emission of pollutants.

The response of crops to fertilizers varies widely from place to place, depending upon the fertility level of soil, other environmental conditions and genotypes. Its yield potential and several constraints like foliar diseases also depend on different levels of fertilizer. This necessitates the study on the response of crop to different levels of fertilizer. Maize crop is categorized as a very exhaustive crop because of its very high demand for the nutrients

Specially nitrogen, phosphorus and potassium from the soil. Nitrogen is an essential component of amino acids, which are the building blocks of proteins and is also a part of the DNA molecule, so it plays a very important role in cell division and reproduction (Ali et al., 2012) [1]. The chlorophyll molecule also contains nitrogen. Nitrogen deficiency most often results in slow and stunted growth along with chlorosis. (Cheema et al., 2010) [3]. Most of the nitrogen taken up by plants from the soil in the forms of  $\text{NO}_3^-$ . Amino acids and proteins can only be built from  $\text{NH}_4^+$  so  $\text{NO}_3^-$  must be reduced with split application of ammonical form of nitrogen. Nitrogen is usually applied in splits in the field to avoid various nitrogen losses. Split application full fill the crop requirements at the time of need of the crop (Fanuel and Gifole. 2012) [4].

### Material Methods

The experiment was conducted at Dryland (Karewa) Agricultural Research Station, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during *kharif* 2017. The site is situated between 34.6°N and 74.5°E at an altitude of 1580 above Mean sea level. Climatically the experimental site is in mid to high altitude temperate zone characterized by hot summers and very cold winters. The average annual precipitation is 790.4 mm (average of past 30 years) most of which is received from December to April in the form of snow and rains. The soil was silty clay loam with neutral in reaction (pH 6.9) and EC 0.12. The soil was low in Nitrogen (253.7) and Phosphorus (19.4) but medium in Potassium (118.34) and Organic content (0.99). Experiment was laid in split-split plot design assigning three Sowing Dates 19<sup>th</sup> Standard Metrological week (May 02-May 08) (D<sub>1</sub>), 21<sup>th</sup> Standard Metrological week (May 16-May 22) and 23<sup>rd</sup> Standard Metrological week (May 30-June 05). Two plant spacings were maintained viz: S<sub>1</sub> i.e 60cm X 20cm (83000 plants ha<sup>-1</sup>) and S<sub>2</sub> i.e. 60cm X 15cm (104166 plants ha<sup>-1</sup>) along with three nitrogen levels viz: N<sub>1</sub> =90 kg ha<sup>-1</sup> N<sub>2</sub> =120 kg ha<sup>-1</sup> and N<sub>3</sub>=150 kg ha<sup>-1</sup>. Nitrogen uptake and content at various growth stages was also examined. The total quantity of phosphorus, potassium and zinc sulphate, were applied as per the recommended dose. Well decomposed FYM @ 10 t ha<sup>-1</sup> was mixed in soil as per the recommended dose. Urea, DAP, MOP and zinc sulphate were used as source of nitrogen, phosphorus, potassium, and zinc respectively (120 kg N/ha, 60 kg P<sub>2</sub>O<sub>5</sub>/ha, 30 kg K<sub>2</sub>O/ha, 20 kg ZnSO<sub>4</sub>/ha). Phorate was applied @ 20 kg ha<sup>-1</sup> one day before sowing for control of cutworms.

Certified seed of maize variety “Shalimar Popcorn 1” was used in the experiment. It has vigorous medium tall plants with a tendency to bear 2 cobs per plant. Cobs are long, tapering towards the end with bright orange flint grains. It has a yield potential of 55 to 60 quintals per hectare. It matures in 155 to 160 days in the valley and 125 to 130 days in the mid elevations. Harvesting was done when the husk of cobs turned brownish yellow. The harvested plants were left on soil surface in respective plots for 3-4 days for sun drying. After sun drying, biomass was recorded with the help of balance. Five plants were randomly selected and tagged from every plot of each replication and then average for every parameter was worked out and recorded after every 15 day interval.

### Result and Discussion

#### Effect on grain yield (ton ha<sup>-1</sup>) and stover yield (ton ha<sup>-1</sup>)

With respect to nitrogen management practices, significantly lowest grain yield (2.98 and 3.23 tonha<sup>-1</sup>) was obtained in N<sub>1</sub> (90kg/ha) treatment in 2016 and 2017 respectively. N<sub>2</sub> (120

kg/ha) and N<sub>3</sub> (150 kg/ha) treatments were at par with each other having grain yield of 3.50 (2016), 3.76 (2017) and 3.58 (2016), 3.83 (2017) tonha<sup>-1</sup> respectively. It is clearly depicted in the table 1, that increase in the dose and frequency of nitrogen application increases the grain yield significantly and consistently.

On examining the effect of nitrogen levels on stover yield, it was observed that treatments N<sub>2</sub> (120 kg/ha) and N<sub>3</sub> (150 kg/ha) resulted higher stover yield and were at par with each other. Significantly lowest stover yield (4.93 and 5.29 ton ha<sup>-1</sup>) was obtained for N<sub>1</sub> (90 kg/ha) during 2016 and 2017 respectively.

Effect of nitrogen management practices on grain and stover yield and its components analysis helps in estimating the relative harvest index. There was significant increase in grain and stover yield of maize with increase in nitrogen dose and application frequency. The increase in maize grain and stover yield with increasing nitrogen dose and splitting was mainly due to its better contribution towards different yield contributing characteristics like higher functional leaves, LAI, dry matter accumulation and other attributing characters. N<sub>2</sub> (120 kg/ha) and N<sub>3</sub> (150 kg/ha) treatments were at par with each other having grain yield of 3.50 (2016), 3.76 (2017) and 3.58 (2016), 3.83 (2017) tonha<sup>-1</sup> respectively. Significantly lowest grain yield (2.98 and 3.23 tonha<sup>-1</sup>) was obtained in N<sub>1</sub> (90kg/ha) treatment in 2016 and 2017 respectively. On examining the effect of nitrogen levels it was observed that treatments N<sub>2</sub> (120 kg/ha) and N<sub>3</sub> (150 kg/ha) resulted higher stover yield and were at par with each other. Significantly lowest stover yield (4.93 and 5.29 ton ha<sup>-1</sup>) was obtained for N<sub>1</sub> (90 kg/ha) during 2016 and 2017 respectively. This could be due to the fact that optimum nitrogen fertilization resulted in better nutrient supply and uptake by the plants resulting in improved vegetative growth and higher value of yield attributes. Similar results were reported by Kour *et al.* (2015) [7]. Parmar and Sharma (2001) [10] also reported that there was significant increase in maize grain yield, with increase in N dose and this could be attributed to improved growth, better availability of nutrients at vital growth period and synthesis of carbohydrates and their translocation. Singh *et al.* (2000) [13] observed that grain and stover yield of maize increased significantly from 26.7 to 57.1 q ha<sup>-1</sup> when nitrogen level was increased from 0 to 150 kg N ha<sup>-1</sup>. Nitrogen treatments 120 kg/ha (N<sub>2</sub>) and 150 kg/ha (N<sub>3</sub>) obtained highest biological yield and were at par with each other, whereas treatment N<sub>1</sub> (90kg/ha) resulted in significantly lowest biological yield during 2016 and 2017 as well.

#### Effect on biological yield (ton ha<sup>-1</sup>) and harvest index

As regards the effect of nitrogen on biological yield, nitrogen treatments 120 kg/ha (N<sub>2</sub>) and 150 kg/ha (N<sub>3</sub>) obtained highest biological yield and were at par with each other, whereas treatment N<sub>1</sub> (90kg/ha) resulted in significantly lowest biological yield during 2016 and 2017 as well, as depicted in table 1.

Data pertaining to harvest index during 2016 and 2017 is presented in table 1. From the perusal of data it was observed that HI was higher during 2017 whereas, sowing date, spacing and nitrogen levels had no significant effect on harvest index during the years 2016 and 2017.

Economic yield of a crop was the outcome and contribution of its different yield components and therefore, optimization of the contribution of these yield components through judicious and equitable nitrogen management practices helps in the harvesting of maximum yield. In the present investigation

higher dose of nitrogen resulted in the increase in yield components like cob length, number of grains per cob, number of cobs per plant, etc. significant differences as compared to lower nitrogen levels were observed with the application of different nitrogen management practices and the maximum effect was observed with the application of highest nitrogen level of (N<sub>3</sub>) treatment. This might be due to higher dose of nitrogen which facilitated the growth of the plant and that improve the photosynthetic area which was

responsible for higher net photosynthesis and higher dry matter accumulation that ultimately increased the biological yield and yield attributing characters. Sabir *et al.* (2000)<sup>[11]</sup> and Mahmood *et al.* (2001)<sup>[8]</sup> observed that number of grains per cob increased significantly with increasing nitrogen rates. Shanti *et al.* (1997)<sup>[12]</sup> also observed significant increase in yield attributes *viz.*, cob length, cob girth and 1000-grain weight of maize with increase in nitrogen application dose.

**Table 1:** Yield attributes of popcorn as influenced by Nitrogen Levels.

Treatments	Grain yield(t/ha)		Stover yield (t/ha)		Biological yield(t/ha)		Harvest index (%)	
	2016	2017	2016	2017	2016	2017	2016	2017
<b>Nitrogen Levels</b>								
90 kg/ha (N <sub>1</sub> )	2.98	3.23	4.93	5.29	7.91	8.52	37.14	37.47
120 kg/ha (N <sub>2</sub> )	3.50	3.76	5.80	6.16	9.31	9.92	37.27	37.54
150 kg/ha (N <sub>3</sub> )	3.58	3.83	5.88	6.24	9.46	10.07	37.30	37.56
SE (m)±	0.09	0.1	0.12	0.19	0.26	0.28	0.09	0.08
CD(P≤0.05)	0.27	0.30	0.64	0.58	0.78	0.85	NS	NS

### Effect on quality parameters

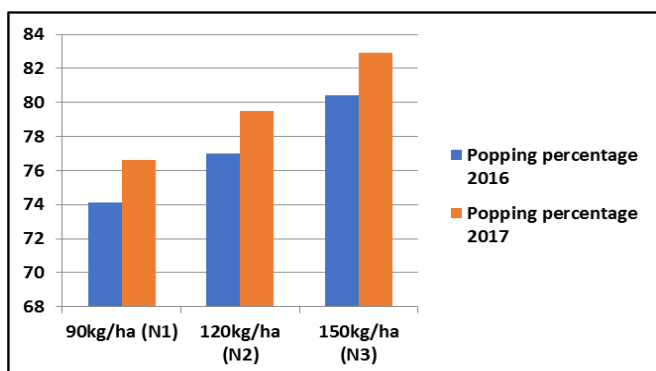
As far as popping percentage is concerned, it was observed from table 2 and fig 1, that three treatments N<sub>1</sub> (90 kg/ha) N<sub>2</sub> (120kg/ha) and N<sub>3</sub> (150kg/ha) when compared in order, were at par with each other, but treatment N<sub>3</sub> produced significantly higher popping percentage of 80.41 and 82.91% when

compared to N<sub>1</sub> which had 74.12 and 76.62% during the years 2016 and 2017 respectively.

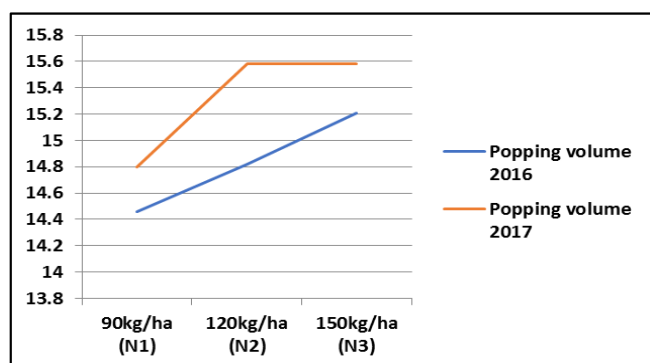
As far as popping volume is concerned, effect of nitrogen level treatments 90kg/ha (N<sub>1</sub>), 120kg/ha (N<sub>2</sub>) and 150kg/ha (N<sub>3</sub>) on popping volume was also statistically at par as shown in table 2 and figure 2.

**Table 2:** Popping percentage and popping volume of popcorn as influenced by Nitrogen Levels.

Treatments	Popping percentage		Popping volume	
	2016	2017	2016	2017
<b>Nitrogen Levels</b>				
90kg/ha (N <sub>1</sub> )	74.12	76.62	14.46	14.80
120kg/ha (N <sub>2</sub> )	76.98	79.48	14.82	15.58
150kg/ha (N <sub>3</sub> )	80.41	82.91	15.21	15.58
SE (m)±	0.155	0.155	0.017	0.018
CD(P≤0.05)	0.448	0.449	0.050	0.052



**Fig 1:** Popping percentage in popcorn as influenced by Nitrogen Levels.



**Fig 2:** Popping volume in popcorn as influenced by Nitrogen Levels

### Effect on nitrogen content and uptake

Nitrogen content of both plant at anthesis, stover and grain at harvest during 2016 and 2017 was analyzed and presented in the table 3. It was revealed from the data that the nitrogen concentration in the plant at anthesis, grain and stover at harvest no significant differences were determined in above components for different sowing dates. With respect to nitrogen levels, treatment N<sub>3</sub> (150kg/ha) resulted in significantly higher N content of 1.72 and 1.73 at anthesis and in grain 1.63 and 1.73 at harvest during 2016 and 2017. Treatment N<sub>1</sub> (90kg/ha) resulted in significantly lowest nitrogen content in plant at anthesis and in grain at harvest. It was observed that the N content in popcorn stover due to three nitrogen level treatments was statistically at par.

As far as Nitrogen uptake is concerned, the total uptake of a nutrient by plant depends along with other factors on the availability of these nutrients in the growing medium. Studies on the nitrogen uptake in the plant tissue at anthesis, grain, stover and harvest revealed that the uptake of nitrogen was higher during 2017 as compared with the data recorded during 2016, as shown in table 4.

As regards the effect of nitrogen levels on nitrogen uptake at anthesis, grain, stover and harvest, it was observed that there was a higher uptake of nitrogen with increase in nitrogen supply at all stages under experiment. Treatment 150kg/ha (N<sub>3</sub>) resulted in significantly higher nitrogen uptake (94.65) over N<sub>1</sub> and N<sub>2</sub> at anthesis stage. In the grain, it was observed that treatment N<sub>1</sub> influenced significantly lowest nitrogen

uptake (46.19 in 2016 and 51.35 in 2017) against N<sub>2</sub> (55.65 and 61.28) and N<sub>3</sub> (58.35 and 63.57) which were statistically at par with each other. In the grain nitrogen uptake was also significantly lower for treatment N<sub>1</sub> and treatments N<sub>2</sub> and N<sub>3</sub> were at par. At the harvest stage treatment N<sub>3</sub> resulted in significantly higher uptake of nitrogen over N<sub>1</sub> and N<sub>2</sub>.

Treatment N<sub>1</sub> (90kg/ha) resulted in significantly lowest nitrogen content in plant at anthesis and in grain at harvest. It was observed that the N content in popcorn stover due to three nitrogen level treatments was statistically at par. Grain nitrogen content was more than stover which might have due to translocation of nitrogen from vegetative parts towards grain leaving stover poor in nitrogen (Hatwar *et al.*, 1992)<sup>[5]</sup>. The total uptake of a nutrient by plant depends along with other factors on the availability of these nutrients in the growing medium. In the current experiment, the effect of nitrogen levels on nitrogen uptake was calculated at anthesis, grain, stover and harvest. It was observed that there was a higher uptake of nitrogen with increase in nitrogen supply at all stages under experiment. Treatment 150kg/ha (N<sub>3</sub>) resulted

in significantly higher nitrogen uptake (94.65) over N<sub>1</sub> and N<sub>2</sub> at anthesis stage. In the grain, it was observed that treatment N<sub>1</sub> influenced significantly lowest nitrogen uptake (46.19 in 2016 and 51.35 in 2017) against N<sub>2</sub> (55.65 and 61.28) and N<sub>3</sub> (58.35 and 63.57) which were statistically at par with each other. In the grain nitrogen uptake was also significantly lower for treatment N<sub>1</sub> and treatments N<sub>2</sub> and N<sub>3</sub> were at par. At the harvest stage treatment N<sub>3</sub> resulted in significantly higher uptake of nitrogen over N<sub>1</sub> and N<sub>2</sub>. The higher levels of nitrogen resulted in more uptake of nutrients compared to other treatments might be due to higher dry matter production. The higher uptake of nitrogen under high nitrogen input might be due to balanced and higher application of nutrients resulting in more availability and uptake of nutrients. Similar results were reported by the findings of Wadile *et al.* (2017)<sup>[14]</sup>. Brar and Cheema (1988)<sup>[2]</sup> reported significant increase in N-uptake with 120 kg N ha<sup>-1</sup> as compared to 80 kg N ha<sup>-1</sup>. This can be supported by the findings of Inshin and Vishnyakova (1991)<sup>[6]</sup> and Mishra *et al.* (1994)<sup>[9]</sup>.

**Table 3:** N content of popcorn as influenced by Nitrogen Levels.

Treatments	N content at anthesis (plant)		N content at maturity (seed)		N content at maturity (stover)	
	2016	2017	2016	2017	2016	2017
<b>Nitrogen Levels</b>						
90kg/ha (N <sub>1</sub> )	1.61	1.62	1.55	1.59	0.64	0.65
120kg/ha (N <sub>2</sub> )	1.66	1.67	1.59	1.63	0.67	0.68
150kg/ha (N <sub>3</sub> )	1.72	1.73	1.63	1.73	0.70	0.70
SE (m)±	0.001	0.001	0.002	0.005	0.002	0.001
CD(P≤0.05)	0.003	0.003	0.003	0.006	0.005	0.003

**Table 4:** N uptake of popcorn as influenced by Nitrogen Levels.

Treatments	N uptake at anthesis		N uptake at harvest (seed)		N uptake at maturity (stover)		N uptake at harvest	
	2016	2017	2016	2017	2016	2017	2016	2017
<b>Nitrogen Levels</b>								
90kg/ha (N <sub>1</sub> )	82.86	153.96	46.19	51.35	31.55	34.38	82.86	84.43
120kg/ha (N <sub>2</sub> )	89.36	157.55	55.65	61.28	38.86	41.88	89.36	90.32
150kg/ha (N <sub>3</sub> )	94.65	161.50	58.35	63.57	41.16	43.68	94.65	97.36
SE (m)±	1.13		0.72	1.10	0.79	0.81	1.14	1.03
CD(P≤0.05)	3.41	3.33	2.75	3.30	2.37	2.43	3.40	3.09

## References

1. Ali K, Khali SK, Munsif Abdurrab F, Nawab K, Khan AZ, Kamal A, Khan ZH *et al.*, Response of maize to various nitrogen sources and tillage practices, Sarhad J Agric. 2012; 28:9-14.
2. Brar HS, Cheema SS. Agronomic practices for managing excess water in maize. Indian Journal of Agronomy. 1988; 33:164-166.
3. Cheema MA *et al.* Nitrogen management strategies for sustainable maize production. Crop Environ. 2010; 1(1):49-52.
4. Laekemariam, Fanuel, Gifole Gidago. Response of maize (*Zea mays* L.) to integrated fertilizer application in Wolaita, South Ethiopia. Advances in Life Science and Technology. 2012; 5:21-30.
5. Hatwar KG, Rahate VT, Thakare JT. Nitrogen uptake behaviour of summer maize as influenced by sowing dates, spacing and nitrogen levels. Annals of Plant Physiology. 1992; 6(2):252-257.
6. Inshin NA, Vishnyakova EN. Productivity of maize depending on fertilizer rate, plant density and row spacing. Agrokhimiya. 1991; 6:37-45 (c.f.CAB Abstracts CD\_ROM 1990-1992/94).
7. Kour L, Thakur NP, Kumar P, Chark AS. Productivity and profitability of Maize as influenced by intercropping of rajmash and nutrient management techniques under sub alpine conditions of Jammu India. Legume Research, 39(6), 970-975
8. Mehmood MT, Maqsood M, Awan TH, Sarwar R, Hussain HI. Effect of different level of nitrogen and intra row plant spacing on yield components of maize. Pakistan Journal Agricultural Science. 2001; 38:48.
9. Mishra B, Yadav RS, Rajput AL, Pandey SM. Effect of plant geometry and nitrogen application on yield and quality of winter maize. Indian journal of Agronomy. 1994; 39:468-469.
10. Parmar DK, Vinod Sharma. Nitrogen requirement of single hybrid maize (*Zea mays*)-wheat (*Triticum aestivum*) system under rainfed conditions. The Indian Journal of Agricultural Sciences, 2001, 71.4.
11. Sabir MR, Ahmad I, Shazad MA. Effect of nitrogen and phosphorus on yield and quality of two hybrids of maize. Journal of Agricultural Research. 2000; 38:339.
12. Shanti K, Rao VP, Reddy MR, Reddy MS, Sharma PS. Response of hybrid and composite maize to different levels of nitrogen. Indian Journal of Agricultural Sciences. 1997; 67:326-327.

13. Singh DP, Rana NS, Singh RP. Dry matter production and nitrogen uptake in winter maize (*Zea mays* L.) based intercropping system under different levels of nitrogen. Indian Journal of Agronomy. 2001; 45:676-680.
14. Wadile SC *et al.* Influence of land configuration and nutrient management on yield, quality and economics of soybean (*Glycine max*)-sweet corn (*Zea mays*) cropping sequence. Indian Journal of Agronomy. 2017; 62(2):141-146.
15. Weatherwax P. Popping of corn. Indian academy Science Proceedings, 1922, 199-253.