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Original Research Article

Interactive Effects of Leaf Phenotypes and Nitrogen Fertilizer on the Growth and Yield of Kheksa [*Momordica dioica* Roxb. ex Willd.] under Agro-Climatic Condition of Zone V Prevailing in Giridih District of Jharkhand

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A B S T R A C T

A trial was conducted to study the interactive effects of phenotypes and nitrogen fertilizer on growth and yield of *kheksa* [*Momordica dioica* Roxb. ex Willd.] during *kharif* 2016 and 2017 at the Krishi Vigyan Kendra, Giridih. The results based on two years mean revealed that out of nine different treatments, the vines with tri lobed leaves attended the maximum length of main shoot, number of primary branches at last harvest, internodal length of 3.62, 5.83 and 7.48 cm, respectively. The vines with single lobed leaves showed the maximum number of nodes plant^{-1} of 59.77. Days taken for appearance of first female flower and first harvest were recorded minimum (showing their earliness characteristics) in vines with single lobed leaves (64.55 and 82.77, respectively). Fruit length and weight and number of fruits plant^{-1} (3.95 cm, 13.55 g and 72.78) were recorded maximum from vines with single lobed leaves. However, maximum fruit diameter was found in vines with tri lobed leaves (3.03 cm). Vines with single lobed leaves produced maximum weight of fruits vine^{-1} (1.67 kg) resulting maximum fruit yield of 41.60 q ha^{-1}. Plants fertilized with nitrogen @ 300 Kg ha^{-1} attended maximum growth and yield attributes. However, yield of 35.57 q ha^{-1} was recorded maximum from plants fertilized with nitrogen @ 300 Kg ha^{-1}.

Keywords

Leaf phenotypes, nitrogen fertilizer, agro-climatic condition

Introduction

Kheksa (*Momordica dioica* Roxb. ex Willd.) also known as kakrol / teale gourd / spine gourd / bristly balsam pear / prickly carolaho / kantola / kakora / padora / carolaho and belongs to family Cucurbitaceae under the genus *Momordica*, a genus of annual and perennial climbers that contains about 80 species with chromosome number 2n=28. It is generally a vegetatively propagated dioecious crop.

This genus is essentially a native of tropical regions of Asia with extensive distribution in China, Japan, South East Asia, Polynesia besides Tropical Africa and South America. Out of total 80 species, 7 species are available in India and many of the species grow wildly in Bangladesh, Srilanka, Mynamar, Malaya, etc. In Jharkhand, cultivation by farmers has not been reported yet, except backyard cultivation by farmers

that can be counted on fingers. However, fruits collected from forest areas, the main home of this crop in this region, are being sold at a high price rate in urban areas. It has a great opportunity for its cultivation as irrigated crop under scaffolding or machan system. *Kheksa* can be cultivated here for a period of 7-8 months starting from mid-April to November.

Nitrogen fertilization favors the development of the aerial parts over roots and consequently the promotion of flowering and fruiting of many crops. *Kheksa* with huge vegetative growth needs high amounts of nitrogen to cover its requirements. Hence, there is a need to standardize the optimum level of nitrogen for getting higher yields.

With this background the present study was undertaken to assess the interactive effects of leaf phenotypes and nitrogen fertilizer on the growth and yield of *kheksa* under agro-climatic condition of Zone V prevailing in Giridih district of Jharkhand.

Materials and Methods

The present investigation was carried out as on-farm trial at the Krishi Vigyan Kendra, Giridih during *Kharif* planting seasons of 2016 and repeated in 2017 on Kheksa (*Momordica dioica* Roxb. ex Willd.). Three phenotypes namely vines with single, tri and penta lobed leaves were grown in the main field in pits of 1 x 1^ size, arranged at 2 x 2 m spacing. Male plants were also grown as bulk at a ratio of 1:10 to ensure enough pollen for females. The crop was fertilized with nitrogen in the form of urea as per the treatment scheduled (100, 200 and 300 kg N ha^{-1}) at 15, 30 and 45 days after planting in main field. Entire phosphorus and potassium are applied as basal dose in the form of single super phosphate and murate of potash @ 125 kg ha^{-1}, respectively. Need based manual hand weeding was done and the plots were kept free of weeds. The crop was immediately irrigated after planting & subsequent irrigations were given at 3-5 days interval depending upon the moisture condition of experimental plot to maintain uniform soil moisture throughout crop growth period. Staking of plants is done using available wild bushes individually to each plant to ensure individual plant data. Need based plant protection measures were taken up to keep the plot free from pests and diseases and raise a healthy crop. The plants of *kheksa* were grown under three doses of nitrogen fertilizer in the plot size of 8.0 X 8.0 m^2 consisting sixteen plants per plot and laid out in 3 X 3 factorial in Randomized Complete Block Design (RCBD) replicated thrice. Uniform cultural practices were followed for the experiment. The soil of the experimental field was sandy loam in texture with pH 5.8 and organic carbon 0.5 %. Observations on four plant characters viz. length of main shoot (m), number of primary branches at last harvest, internodal length (cm) and number of nodes $plant^{-1}$, days taken for appearance of first female flower and days taken for first harvest and yield and yield attributes namely fruit length and diameter (cm) and weight (g), number of fruits $plant^{-1}$, fruit weight $vine^{-1}$ (kg) and fruit yield (q ha^{-1}) were recorded. The data on growth parameters and yield attributes were pooled and analyzed statistically as per Gomez and Gomez, 1984 and presented in Table -1 and 2 and Figure 1.

Results and Discussion

Perusal of the data (Table -1) clearly indicated that the significant differences existed in all plant growth characters, flowering and fruiting. Considerable variations in the length of main shoot were observed among the three phenotypes. Such

variations were also observed among different strains and cultivars of kakrol by Maharana *et al.,* (1995) and Rasul *et al.,* (2004). Application of fertilizers at different levels brought about significant differences in length of the main shoot with highest of 3.87 m at 300 kg N ha^{-1} and lowest (3.23 m) at 100 kg N ha^{-1}. Same result was also observed by Nek *et al.,* (2000), Reddy and Rao (2004), Shantappa *et al.,* (2005), Prasad *et al.,* (2009), Baset Mia *et al.,* (2011) in case of bitter gourd. The increase in vine length at higher levels of nitrogen may be due to higher uptake of nitrogen as evident from Table 1. There shall be increased auxins, gibberellins, cytokinins and ethylene with increase in carbohydrates and amino acids due to increase in nitrogen levels (Maynard and David, 1987). It is evident from the data that the increase in the number of primary branches at harvest was significant among phenotypes and nitrogen levels. The highest number of primary branches (5.83) was observed in vines with tri- lobed leaves, followed by the vines with single lobed leaves with 5.35 in number. Lowest number of primary branches (4.87) was observed in vines with penta lobed leaves. Similar variation in number of kakrol strains / cultivars was observed by Rasul *et al.,* (2004). Maximum number of primary branches at harvest (6.0) was recorded with the application of 300 kg N ha^{-1} followed by 200 kg N ha^{-1} with 5.30 branches, whereas, the minimum number of primary branches at harvest (4.08) was recorded with the application of 100 kg N ha^{-1}. Shariful Islam and Irabangon (1994) also found that the number of branches was highest at 240 kg N ha^{-1} in bitter gourd.

The variation in internodal length among the treatments was found to be non-significant. The increase in number of nodes per plant at harvest was significant among phenotypes and nitrogen levels. The highest number of nodes per vine (59.77) was observed in plant with single lobed leaves, followed by vines with tri lobed leaves with 55.60 nodes. Lowest number of nodes per plant (49.77) was observed in vines with penta lobed leaves. Rasul *et al.,* (2004) also observed variation in number of nodes due to genotypes in kakrol. Maximum number of nodes per vine at harvest (57.07) was recorded with the application of 300 kg N ha^{-1} which was followed by with application of 200 kg N ha^{-1} recording 55.63 nodes. Similar increase in number of nodes and fruits with increased levels of nitrogen was also reported by Suresh and Pappaih (1991) in bitter gourd which may be due to increased vegetative growth consequent to the increased production of auxins and carbohydrates.

Significant differences were observed among the different phenotypes and nitrogen on number of days taken to appearance of first female flower. Maximum number of days taken to appearance of first female flower (69.44) was observed in vines with tri lobed leaves followed by vines with penta lobed leaves with 67.78 days. The minimum number of days taken to appearance of first female flower (64.55) was observed in vines with single lobed leaves. Similarly, there was an increase in the days taken for appearance of first female flower with increase in levels of nitrogen.

Early flowering (64.77days) was observed with application of 100 kg N ha^{-1} and late flowering (69.77 days) was observed with application of 300 kg N ha^{-1}. This may be due to general tendency of plants towards vegetative phase with increased levels of nitrogen as observed in many crops. Prasad *et al.,* (2009) has also reported similar finding with kakrol. The days to first harvest were not significant among phenotypes and due to nitrogen application.

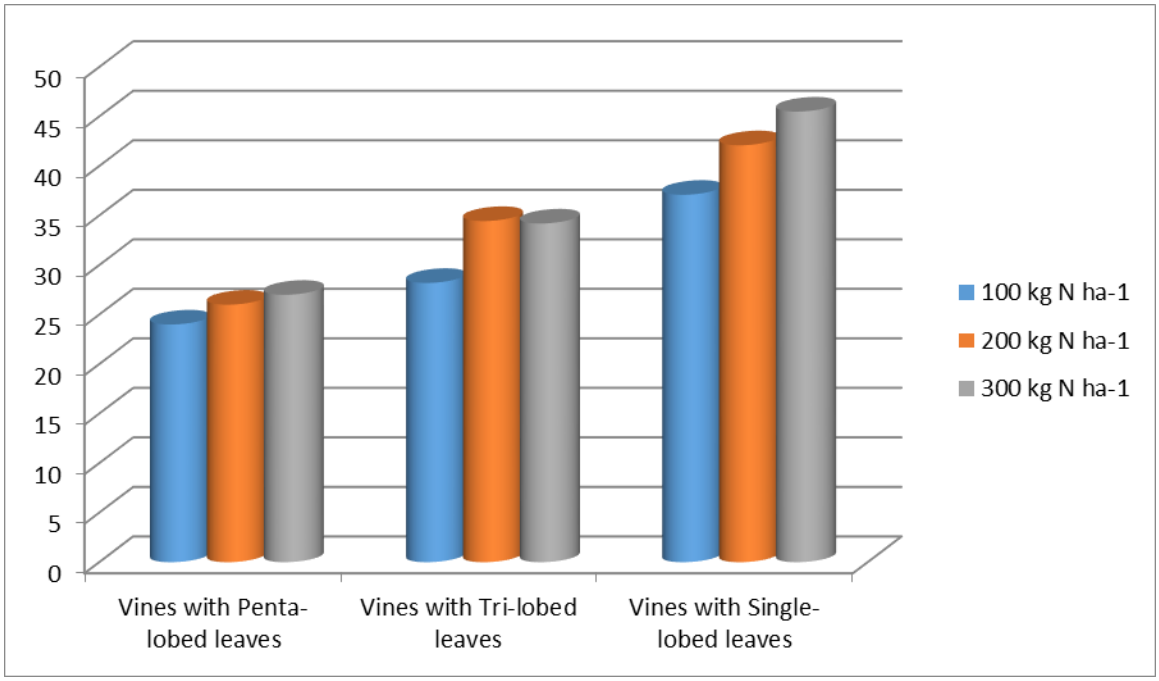
Table.1 Growth parameters, flowering and fruiting of *kheksa* [*Momordica dioica* Roxb. ex Willd.] as influenced by leaf phenotype and nitrogen fertilizer

Treatments	Length of main shoot (m)	No. of primary branches at last harvest	Internodal length (cm)	No. of nodes plant^{-1} at last harvest	Days taken for appearance of first female flower	Days taken for first harvest
Leaf phenotype						
Vines with Penta-lobed leaves	3.38	4.87	7.30	49.77	67.78	84.77
Vines with Tri-lobed leaves	3.62	5.83	7.48	55.60	69.44	89.33
Vines with Single-lobed leaves	3.35	5.35	6.88	59.77	64.55	82.77
CD $_{0.05}$	NS	0.30	NS	1.07	2.41	NS
Nitrogen						
100 Kg ha^{-1}	3.23	4.08	6.80	52.43	64.77	86.00
200 Kg ha^{-1}	3.25	5.30	7.10	55.63	67.22	87.33
300 Kg ha^{-1}	3.87	6.00	7.77	57.07	69.77	83.55
CD $_{0.05}$	0.58	0.30	0.49	1.07	2.41	NS

Table.2 Yield and yield attributes of fruits of *kheksa* [*Momordica dioica* Roxb. ex Willd.] as influenced by leaf phenotype and nitrogen fertilizer

Treatments	Fruit length (cm)	Fruit diameter (cm)	No. of fruits plant^{-1}	Fruit weight (g)	Fruit weight vine^{-1} (kg)	Fruit yield (q ha^{-1})
Leaf phenotype						
Vines with Penta-lobed leaves	3.59	2.88	49.12	12.16	0.88	25.67
Vines with Tri-lobed leaves	3.90	3.03	53.12	12.90	1.11	32.28
Vines with Single-lobed leaves	3.95	2.97	72.78	13.55	1.67	41.60
CD $_{0.05}$	0.19	NS	2.02	0.11	0.06	0.05
Nitrogen						
100 Kg ha^{-1}	3.66	2.95	54.95	12.69	1.23	29.80
200 Kg ha^{-1}	3.84	3.02	58.12	12.95	1.32	34.18
300 Kg ha^{-1}	3.95	2.93	61.95	12.99	1.12	35.57
CD $_{0.05}$	NS	NS	2.02	0.11	0.06	0.05

Fig.1 Interactive effect of leaf phenotype and nitrogen on Fruit Yield of *kheksa* (q ha^{-1}) [*Momordica dioica* Roxb. ex Willd.]



The data pertaining to the yield parameters i.e, fruit length (cm), fruit diameter (cm), number of fruits per plant, fruit weight(g) and fruit weight (kg) vine^{-1} and fruit yield (q ha^{-1}), as influenced by different phenotypes and nitrogen application are presented in the Tables 2. The fruit length (cm) was found significant among the phenotypes. The highest fruit length (3.95 cm) was observed in vines with single lobed leaves which is at par by vines with tri lobed leaves with 3.90 cm. Lowest fruit length (3.59 cm) was observed in vines with penta lobed leaves. Similar differences in fruit size in kakrol strains / cultivars were also reported by Rasul *et al.*, (2004). The length and diameter of furit were not found significant due to nitrogen application.

Maximum number of fruits per plant (72.78) was observed in vines with single lobed leaves followed by vines with tri lobed leaves with 53.12 fruits. The minimum number of fruits per plant (49.12) was observed in vines with penta lobed leaves. Similar variation in noumber of fruits in different strains/cultivars of kakrol was also observed by Maharana *et al.*, (1995), Rasul *et al.*, (2004) and Anonymous (2005). Maximum number of fruits per plant (61.95) was recorded with the application of 300 kg N ha^{-1} followed by 200 kg N ha^{-1} bearing 58.12 fruits, whereas, the minimum number of fruits per plant (54.95) was recorded with the application of 100 kg N ha^{-1}. Similar findings were reported by Kiranpatro and Mallareddy (2007) where higher number of fruits per vine (66) was obtained from 240:160:75 kg NPK ha^{-1}. On the other hand the increase in number of fruits was also due to increase in number of nodes on account of increased number of primary and secondary branches either due to increased nitrogen or phenotypes. It was also reported by Parmar *et al.*, (2011) in bitter gourd. The higher number of branches and nodes per plant could be also attributed to the higher fruit number.

The highest fruit weight (13.55 g) was observed in vines with single lobed leaves, followed by vines with tri lobed leaves with 12.90 g. Lowest mean fruit weight (12.16 g) was observed in vines with penta lobed leaves. Similar variation in fruit weight of different strains / cultivars of kakrol were also reported by Maharana *et al.,* (1995), Puzari (1999) and Rasul *et al.,* (2004) which may be due to increase in fruit length and diameter due to phenotypes. Highest fruit weight (12.99g) was recorded with the application of 300 kg N ha^{-1} which is at par with 200 kg N ha^{-1} with 12.95, whereas, the lowest fruit weight (12.69 g) was recorded with the application of 100 kg N ha^{-1}. This may be due to the increase in fruit length and diameter and also due to increased nutrition to the vines with increase in levels of nitrogen and increased synthesis of chlorophyll and amino acids (Dzevelin, 1973).

Maximum fruit yield per vine (1.67 kg) was observed in vines with single lobed leaves followed by vines with tri lobed leaves with 1.11 kg. The minimum fruit yield per vine (0.88 kg) was observed in vines with penta lobed leaves. It was reported that kakrol vines with single lobed leaves was found to be prolific and yield better with 90 fruits (1.5 kg/vine) compared with those with penta lobed leaves with 46 fruits giving 0.7 kg per vine. (Anonymous, 2005).Maximum fruit yield per vine (1.32 kg) was recorded with the application of 200 kg ha^{-1} followed by 100 kg N ha^{-1} bearing 1.23 kg fruits. Whereas, the minimum fruit yield per vine (1.12 kg) was recorded with the application of 300 kg N ha^{-1}.

A significant yield variation was noticed among the phenotypes. Though the highest fruit yield was obtained by the phenotype – vine with single lobed leaves (41.60 q ha^{-1}), a phenotype producing maximum number of fruits $plant^{-1}$ to a tune of 72.78 and fruit weight (13.55 g) and production of fruits $vine^{-1}$ with respect of weight (1.67 kg). Poor yield (25.67 q ha^{-1}) of the phenotype – vine with penta lobed leaves, a genotype having poor vegetative growth, might be due to lower number and weight of fruits $plant^{-1}$. Maximum fruit yield (35.57 q ha^{-1}) was recorded with the application of 300 kg N ha^{-1} followed by 200 kg N ha^{-1} producing 34.18 q ha^{-1} fruits. Whereas, the minimum fruit yield (29.80 q ha^{-1}) was recorded with the application of 100 kg N ha^{-1}.

Application of NPK fertilizer to the soil was necessary due to its low fertility in order to increase the crop growth and productivity which was in agreement with the results obtained by Shiyam *et al.,* (2007) and Mare and Modi (2009) in case of taro. A crop response to fertilizer is higher in soil with low nutrient contents than soil with high nutrient reserve (Tisdale and Nelson, 1975). Significant effect on the growth parameters and total yield of the cultivar (Table – 1 & 2) could be attributed to the maximum ecological factors which triggered high photosynthetic activities to produce enough photosynthates deposited in the economic yield character - fruit. This agreed with the result obtained by Ahmed and Badr (2009) and Orji *et al.,* (2016). It is evident from studied figure reveal that both phenotype and application of NPK fertilizer had a significant effect on the fruit yield of *kheksa*. But phenotype was found to be more responsive to yield than that of application of N fertilizer (Fig. 1). However, with the interaction of phenotype – nitrogen fertilizer at increased rates significantly increased the studied parameter of yield at increased levels. The highest yield of *kheksa* plants with single lobed leaves were obtained 45.50 q ha^{-1} closely followed by vines with tri lobed leaves shown under application of nitrogen fertilizer @ 200 Kg ha^{-1} and

significantly differed over other treatment combinations of phenotype and nitrogen fertilizer.

In last, it can be concluded that cultivation of kheksa vines having single lobed leaves planted under fertilizer application of nitrogen @ 300 Kg ha^{-1} will be attractive and beneficial for *kheksa* [*Momordica dioica* Roxb. ex Willd.] cultivation by the farmers of Giridih district and adjoining areas of agro-climatic condition of Zone V of Jharkhand

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