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Studies on the Effect of N, P, K Levels and Plant Densities on Growth, Yield and Quality of Pointed Gourd (*Trichosanthes dioica* Roxb.)

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A B S T R A C T

The present study pertains to the effect of N,P,K levels, plant densities and its interaction on growth, yield and quality of pointed gourd (*Trichosanthes Dioica* Roxb.) was undertaken at College of Horticulture, Dr. Y.S.R Horticultural University, Venkataramannagudem, West Godavari District of Andhra Pradesh during *kharif* 2015-2016. An experiment was carried out with 12 different treatment combinations in factorial randomized block design (FRBD) replicated thrice which are (T_1)- F_1 S_1: 125:50:50 NPK kg ha^{-1}+1mx1m; (T_2)-F_1 S_2: 125:50:50 NPK kg ha^{-1}+1.5mx1.5m; (T_3)- F_1 S_3: 125:50:50 NPK kg ha^{-1}+1.5mx1m; (T_4)- F_2 S_1: 150:60:60NPK kg ha^{-1}+1mx1m; (T_5)- F_2 S_2: 150:60:60NPK kg ha^{-1}+1.5mx1.5m; (T_6) F_2 S_3: 150:60:60NPK kg ha^{-1}+1.5mx1m; (T_7)- F_3 S_1: 175:70:70 NPK kg ha^{-1}+1mx1m; (T_8)-F_3 S_2: 175:70:70 NPK kg ha^{-1}+1.5mx1.5m; (T_9)-F_3 S_3: 175:70:70 NPK kg ha^{-1}+1.5mx1m; (T_{10})-F_4 S_1: Control+1mx1m; (T_{11})-F_4 S_2: Control+1.5mx1.5m; (T_{12})- F_4 S_3: Control+1.5mx1m. Among the treatment combinations of N,P,K levels and plant densities, the treatment combination (T_6) F_2 S_3:150:60:60 NPK kg/ha + 1.5m x 1m recorded maximum values for growth, yield and quality parameters *viz.*, number of nodes per vine, number of primary branches per vine, number of fruits per vine, fruit length, fruit diameter, yield per vine, yield per plot, total yield, number of seeds per fruit, fruit retention percentage, ascorbic acid content, protein content and total soluble solids and the minimum values were recorded for the parameters node at which first male flower appeared, node at which first female flower appeared, days taken to first harvest and days taken from fruit set to marketable maturity. However, the application of (T_8)-S_2F_3:175:70:70 NPK Kg ha^{-1} + 1.5m x 1.5m recorded maximum main vine length and internodal length whereas (T_3)- F_1 S_3: 125:50:50 NPK Kg ha^{-1} + 1.5m x 1m recorded minimum days taken for opening of first male flower and days taken for opening of first female flower. The application of (T_5)- F_2 S_2: 150:60:60 NPK kg/ha + 1.5m x 1.5m recorded maximum weight of edible fruit, 100 seed weight, reducing sugars and total sugars.

Introduction

Pointed gourd (*Trichosanthes dioica* Roxb.) is the king of gourds and belongs to the family Cucurbitaceae. It is popularly known as parwal, palwal, palmal, parmal, panal, patol and potala (Mondal *et al.*, 2014), which is becoming more popular now a days. It is a perennial and dioecious vegetable that grows as vine with a pencil thickness stem (Hazra *et al.*, 2011). Roots are tuberous with long tap root system. Leaves are dark green, simple cordate, ovate and oblong. Flowers are tubular, white and fruits are oblong and smooth. Propagation of pointed gourd from seed is not desirable due to poor seed germination as well as dioecism which results in around 50% unproductive male plants. Traditionally pointed gourd is multiplied through stem cuttings and root suckers (Pandey and Ram, 2000). It has been observed that growers cultivate local cultivars and follow poor agro-techniques leading to low fruit yield. Lack of knowledge about the package of practices particularly on planting density and proper nutrient management are the prime reasons for lower yields.

Of late, agro techniques like nutrition and spacing play an important role in commercial production. Spacing is an important factor that will influence the plant population and affect the nutrient uptake of plants by creating competition between plants for nutrients, water and availability of light to the plants for synthesizing the food. By manipulation of inter and intra row spacing, several workers reported higher yields in other crops under field conditions (Singh *et al.*, 2007), optimum nitrogen, phosphorus and potassium should be supplied to overcome the bottlenecks of production (Das *et al.*, 1987). Several workers reported higher yields with the application nutrients in other cucurbitaceous crops (Misra *et al.*, 1994). The need of the hour is to improve its production and quality of parwal crop through proper nutrient management. Nitrogen fertilization favours the development of the aerial parts over roots and consequently the promotion of flowering and fruiting of many crops. Pointed gourd has huge vegetative growth which needs high amount of nitrogen (Hazra *et al.*, 2011).

Phosphorus plays an important role in energy transformation and metabolic process of plant and stimulates early root formation and growth, gives a rapid and vigorous growth to plants. Phosphorous is needed in the genetic coding material which controls cell division. Potassium is an important element in plant metabolism, promoting carbohydrate translocation from tops to roots. It plays a major role in the production of fruits. Hence, it is necessary for enhancing the fruit yield and yield attributes. However, information on spacing, nitrogen, phosphorus and potassium requirements of pointed gourd is scarce under Indian conditions. So far, no work has been done on effect of N, P, K levels, plant densities and their interaction on growth, yield and quality parameters of pointed gourd. Hence, the present study was framed out to find better N, P, K management practices, plant densities for higher growth, yield and quality of pointed gourd. Hence, there is a need to standardize the optimum level of nitrogen, phosphorus and potassium for getting higher yields.

Materials and Methods

The experiment was conducted at College of Horticulture, Dr. Y. S.R. Horticultural University, Venkataramannagudem, West Godavari District during 2015-2016.

Soil characteristics

The soil used for experiment is red sandy loam soil, has good drainage and moderate water holding capacity. Soil samples were collected before transplanting the plants from five randomly selected locations at a depth of 0-30

cm from the experimental plot and composite sample was analysed for its physico- chemical properties and presented in Table 1.

Treatment details

The details of the treatments were used are given in Table 2.

Treatments

N, P and K levels - F_1: 125:50:50 NPK kg ha^{-1}
F_2: 150:60:60 NPK kg ha^{-1}
F_3: 175:70:70 NPK kg ha^{-1}
F_4: Control
Plant densities - S_1: S_1-1mx1m (10000 Plants/ha)
S_2: 1.5mx1.5m (4444 Plants/ha)
S_3: 1.5mx1m (6666 Plant/ha)

Land preparation

The land was brought to fine tilth by ploughing and harrowing. The experimental area was divided into plots of 6.0 m x 2.0 m size. Irrigation channels of 1.0 m wide were provided for each row of plots. 30 cm^3 pits were dug at a spacing of 1.0 m x 1.0 m, 1.5m x1.5 and 1.0 m x 1.5m in each plot. Well decomposed farmyard manure @ 10 kg per pit was incorporated by mixing with the soil uniformly as basal application and filled up to 3- 5 cm above the ground level.

Planting

Rooted vine cuttings of 15-20 cm length, pencil thickness and 2-3 months old plants were planted in recommended spacing of 1.0mx1.0m, 1.5mx1.5m and 1.5mx1.0m. A space of 30 centimetres was uniformly left from the borders of the plot. Single rooted cutting was planted per pit.

Manures and Fertilizers

The recommended dosage of N, P and K at 125: 50: 50 $kgha^{-1}$, 150: 60: 60 $kgha^{-1}$ and 175: 70:70 $kgha^{-1}$was applied in the form of urea, single super phosphate and muriate of potash respectively.

Result and Discussion

Effect of N, P, K levels and plant densities on vegetative parameters of pointed gourd

Main vine length (m)

Main vine length differed significantly due to N, P, K level combinations. Significantly maximum main vine length (10.0 m) was observed with F_3 and it was followed by F_2 (7.80 m). The minimum main vine length (5.62 m) was recorded with F_4 control (Table 3). Nitrogen is a very important component of protoplasm and its favourable effect on chlorophyll content of leaves might have increased synthesis of carbohydrates, amino acids *etc*., from which the phytohormones such as auxins, gibberellins, cytokinins and ethylene have been synthesized resulting increased plant height (Maynard and David, 1987). Anjanappa *et al.,* (2012) in cucumber, Kanwar *et al.,* (2013) in sweet pepper, Oloyede *et al.,* (2013) in pumpkin, Arshad *et al.,* (2014) in cucumber, Leghari *et al.,* (2014) in bottle gourd, Das *et al.,* (2015) in bottle gourd, Sureshkumar (2015) in bitter gourd and Umekwe *et al.,* (2015) in cucumber were also reported increased plant height with increase in fertilizer levels.

The effect of plant density on main vine length was found to be significant. Significantly maximum main vine length (8.58 m) was recorded with low plant density (S_2-1.5 x 1.5 m), followed by main vine length (7.45 m) with medium plant density (S_3-1.5 x 1 m). However, the minimum main vine length (6.91 m) was recorded with high plant density

(S_1 -1 x 1 m). This could be due to availability of more space, nutrients, water and less competition from the adjacent plants in wider planting when compared to closer spaced plants. Dash and Tripathy (2001) in pointed gourd, Choudhari and More (2002) in cucumber, Singh *et al.,* (2012) in tomato and Aniekwe and Anike (2015). The interaction effect due to nutrient combinations and plant densities on main vine length was found to be significant. The treatment combination (T_8)-F_3S_2 produced maximum main vine length (11.93 m) which was followed by (T_9)-F_3S_3 (9.55 m). However the treatment combination (T_{10})-F_4 S_1 recorded the minimum vine length (5.26 m). These results are in conformity with the findings of Aidy and Moustafa (1978) in cucumber, Jan *et al.,* (2000) in bottle gourd and Choudhari and More (2002) in cucumber.

Number of nodes per vine

Number of nodes per vine was varied significantly with fertilizer levels and plant densities. It was evident from the data that higher number of nodes per vine (186.08) was recorded with medium plant density S_2:1.5 x 1 m followed by (178.12) the lowest plant density with S_1:1 x 1 m spacing. However the minimum number of nodes per vine (170.83) was recorded with wider plant density S_2:1.5 x 1.5 m (Table 4). These results were in conformity with the findings of Karataev and Salnikova (1982) in parthenocarpic cucumber and Ekmw and Nwokwu (2012) in bhendi. The interaction effect of nutrient combinations and plant densities were non significant in number of nodes per vine.

Effect of N, P, K levels and plant densities on floral parameters of pointed gourd

Days taken for opening of first male flower

Interaction effect due to fertilizer combinations and plant densities on number of days taken for opening of first male flower was found to be significant. The treatment combination (T_3)- F_1 S_3 produced minimum number of days taken for opening of first male flower (40.66 days) which was followed by (T_2)-F_1S_2 (41.00 days). However the treatment combination (T_{10})-F_4S_1 recorded the maximum number of days taken for opening of first male flower (59.00 days) (Fig. 1a). These results were in conformity with the findings of Yadav *et al.,* (1989) in pointed gourd, Vishwakarma *et al.,* (2007) in spine gourd and Prasad *et al., (*2009) in bitter gourd.

Days taken for opening of first female flower

Interaction effect due to fertilizer combinations and plant densities on number of days taken for opening of first female flower was found to be significant. The treatment combination F_1 S_3 produced minimum number of days taken for opening of first female flower (58 days) which was followed by (T_2)-F_1S_2 (60.66 days). However the treatment combination (T_{10})-F_4S_1 and (T_{11})-F_4S_2 recorded the maximum number of days (Fig. 1b) taken for opening of first male flower (72 days). Less number of days taken in the appearance of first female flower with lower doses of nitrogen might be due to poor early vegetative growth and hastening the initiation of reproduction phase. These results were in conformity with the findings of Yadav *et al.,* (1989) in pointed gourd, Vishwakarma *et al.,* (2007) in spine gourd, Prasad *et al., (*2009) in bitter gourd.

Effect of N, P, K levels and plant densities on yield parameters of pointed gourd

Days taken to first harvest

The interaction due to combined effect of N, P, K, levels and plant densities and their interactions was significant. The days taken for first harvest were found to be significant. The treatment combination (T_6)-F_2S_3 produced

minimum days taken to first harvest (63.46) which was followed by (T_5)-F_2S_2 (83.11). However the treatment combination (T_{11})-F_4S_2 recorded the maximum days taken to first harvest (119.35) (Table 5). These results were in conformity with the findings of Yadav *et al.,* (1989); Das *et al.,* (2004) in pointed gourd, Prabhu *et al.,* (2006) in cucumber, Vishwakarma *et al.,* (2007) in spine gourd, Kanwar *et al.,* (2013) in sweet pepper, Kumar *et al.,* (2012) in bottle gourd and Wazed *et al.,* (2013) in snake gourd.

Number of fruits per vine

Effect of N, P, K levels, plant densities and their interaction effect on number of fruits per vine varied significantly. Among the interaction effect, the higher number of fruits per vine (225.67) was recorded with (T_6)-F_2 S_3 followed by (T_5)-F_2 S_2 (198.63), the lower number of fruits per vine (85.00) was recorded (Fig. 2) with (T_{10})-F_4 S_1. These results were in conformity with the findings of Jan *et al.,* (2000) in bottle gourd, Choudhari and More (2002) in cucumber and Patro and Mallareddy (2009) in kakrol.

Yield per vine (kg)

Effect of N, P, K levels, plant density and their interactions differed significantly for yield per vine. The higher yield per vine (9.5 kg vine^{-1}) was recorded with (T_6)-F_2S_3 which was followed by (T_5)-F_2S_2 (8.62 kg vine^{-1}). However the lowest yield per vine (2.21 kg vine^{-1}) was recorded (T_{10})-F_4S_1 (Table 6). These results indicated that the efficiency of nitrogen increased considerably by a simultaneous application of phosphorus and potassium. Improvement of vegetative growth and fruiting could be due to combined application of nitrogen, phosphorus and potassium. The fruit yield per plant in terms of number and total weight of fruits was more in medium spaced plants compared to narrow spaced plants could be due to more number of branches, leaf area, availability of nutrients, light, water and less competition from adjacent plants. These results were in conformity with the findings of Karataev and Salnikova (1982) in parthenocarpic cucumber, Yadav *et al.,* (1989) in pointed gourd, Choudhari and More (2002) in cucumber, Jan *et al.,* (2000) in bottle gourd, Shivashankaramurthy *et al.,* (2007) in gherkins and Patro and Mallareddy (2009) in kakrol.

Yield per plot (kg)

Yield per plot effect on N, P, K levels fertilizers and plant densities differed significantly for yield per plot. The maximum yield per plot (67.90 kg plot^{-1}) was attained with the treatment combination of (T_6)-F_2S_3 which was followed by (T_9)- F_3S_3 (61.70 kg plot^{-1}), whereas (T_{10})-F_4S_1 gave the minimum plot yield (13.50 kg plot^{-1}) compared to the all other treatment combinations (Table 7) and this might be due to nitrogen which results in the increase in the number of leaves, number of branches resulting in the higher chlorophyll and higher photosynthetic activity which helps in the production of carbohydrates which were trans located to the fruits with the help of potassium. Hence the positive response of fruit yield to increased rates of N and K could be due to high starch synthesis and translocation activities stimulated by N and K application. These results were in conformity with the findings of Shivashankaramurthy *et al.,* (2007) in gherkins, Karataev and Salnikova (1982) in parthenocarpic cucumber and Aidy and Moustafa (1978) in cucumber.

Total yield (t ha^{-1})

Increase in NPK level combinations increased the yield significantly in pointed gourd. The higher total yield (41.98 t ha^{-1}) was recorded with the treatment F_2 followed by the treatment F_3 (40.01 t ha^{-1}), whereas lower total yield (12.14 t ha^{-1}) was reported with the

treatment F_4 control. These results were in conformity with the findings of Umamaheswarappa *et al.,* (2002) in bottle gourd, Das *et al.,* (2004) in pointed gourd, Anjanappa *et al.,* (2012) in cucumber, Rani *et al.,* (2012) in pointed gourd, Mia *et al.,* (2014) in bitter gourd and Arshad *et al.,* (2014) in cucumber. The total yield of pointed gourd was significantly influenced by difference in the plant densities. Significantly higher yield (29.60 t ha^{-1}) was recorded with the plant density S_3 followed by the plant density S_2 which recorded yield of 26.53t ha^{-1}, while minimum yield (24.61 t ha^{-1}) was recorded with plant density, S_1 (1 x 1 m). At medium plant density the performance of individual plants was improved with respect to yield components. These results were in conformity with the findings of Singh *et al.,* (2007) in pointed gourd, Oga and Umekwe (2016) in water melon. The interaction effect due to NPK levels combinations and plant densities on total yield was found to be significant. Significantly maximum total yield (47.66 t ha^{-1}) was attained with the treatment combination of (T_6)-F_2 S_3 which was followed by (T_9)-F_3S_3 (46.33 t ha^{-1}), whereas (T_{11})-F_4S_2 gave the minimum total yield (12.00 t ha^{-1}) compared to the all other treatment combinations (Table 8). These results were in conformity with the findings of Aidy and Moustafa (1978) in cucumber, Jan *et al.,* (2000) in bottle gourd and Choudhari and More (2002) in cucumber.

Effect of N, P, K levels and plant densities on quality of pointed gourd

Weight of the edible fruit (g)

The interaction pertaining to N, P, K levels and plant densities recorded higher fruit weight with (T_5)-F_2S_2 (44.9 g) which was followed by (T_6)-F_2S_3 (39.9 g). The lower weight of edible fruit (22.13 g) was recorded with (T_{10})-F_4S_1, which might be due to availability of balanced amount of nutrients and higher rate of assimilation and ultimately more production of carbohydrates and their translocation to the storage organs like fruits. These results indicated that the efficiency of nitrogen increased considerably by a simultaneous application of phosphorus and potassium (Fig. 3a). Improvement of vegetative growth and fruiting could be due to combined application of nitrogen, phosphorus and potassium. Similar results were in conformity with the findings of Umamaheswarappa *et al.,* (2002) in bottlegourd, Choudhary *et al.,* (2007) in capsicum, Jan *et al.,* (2000) in bottle gourd, Choudhari and More (2002) in cucumber and Patro and Mallareddy (2009) in kakrol.

Length of the edible fruit (cm)

The effect of N,P,K fertilizer levels and plant densities recorded higher length of edible fruits with (T_6)-F_2S_3 (14.3 cm) which was followed by (T_8)-F_3S_2 (11.61 cm). The lower length of edible fruit (7.19 cm) was recorded with (T_{10})-F_4S_1 (Fig. 3b). These results were in conformity with the findings of Yadav *et al.,* (1989) in pointed gourd.

Fruit diameter (cm)

The interaction effect of N, P, K fertilizer levels and plant density recorded higher for fruit diameter with (T_6)-F_2S_3 (6.56 cm) which was followed by (T_5)-F_2S_2 (5.85 cm). The lower fruit diameter (3.07 cm) was recorded with (T_{11})-F_4S_2 (Fig. 3c). These results were in conformity with the findings of Choudhari and More (2002) in cucumber and Shivashankara murthy *et al.,* (2007) in gherkins.

Effect of N, P, K levels and plant densities on biochemical parameters of pointed gourd

Ascorbic acid content (mg/100 g)

The combined effect of N, P, K fertilizer levels and plant density and its interaction was

significant in improving the ascorbic acid content. Significantly highest superior ascorbic acid content (33.2 mg) was attained with the treatment combination of (T_6)-F_2S_3 which was followed by (T_5)-F_2S_2 (29.66 mg), whereas (T_{10})-F_4S_1 gave the lowest ascorbic acid content (22.5 mg) compared to the all other treatment combinations (Fig. 4a). The improvement of ascorbic acid content at medium fertilizer levels and plant densities might have led to more nitrogenous compounds in plant tissues and ultimately resulted in their efficient metabolism. These results were in conformity with the findings of Shivashankaramurthy *et al.,* (2007) in gherkins.

Table.1 Physical and chemical properties of soil experimental site

Properties	Value	Method of analysis
A. Physical composition		
Sand (%)	70%	International pipette method (Piper,1966)
Silt (%)	20%	-
Clay (%)	10%	-
Textural class	Red sandy loam	-
B. Chemical composition		
Soil pH	6.98	Digital pH meter (DI-707) (Jackson,1973)
Electrical conductivity(ds m^{-1})	0.26	Conductivity Bridge (Jackson,1973)
Available Nitrogen(kg ha^{-1})	140	Alkaline permanganate method (Subbaiah and Asija,1956)
Available Phosphorus(kg ha^{-1})	41	Olsen's method (Olsen,1954)
Available Potassium(kg ha^{-1})	170	Flame photometer method (Muhr,1965)

Table.2 Combination of N,P,K levels and Plant density treatments

Treatment Notation	Combination of N,P,K levels and Plant density treatments
T_1	F_1 S_1: 125:50:50 NPK kg ha^{-1}+1mx1m
T_2	F_1 S_2: 125:50:50 NPK kg ha^{-1}+1.5mx1.5m
T_3	F_1 S_3: 125:50:50 NPK kg ha^{-1}+1.5mx1m
T_4	F_2 S_1: 150:60:60NPK kg ha^{-1}+1mx1m
T_5	F_2 S_2: 150:60:60NPK kg ha^{-1}+1.5mx1.5m
T_6	F_2 S_3: 150:60:60NPK kg ha^{-1}+1.5mx1m
T_7	F_3 S_1: 175:70:70 NPK kg ha^{-1}+1mx1m
T_8	F_3 S_2: 175:70:70 NPK kg ha^{-1}+1.5mx1.5m
T_9	F_3 S_3: 175:70:70 NPK kg ha^{-1}+1.5mx1m
T_{10}	F_4 S_1: Control+1mx1m
T_{11}	F_4 S_2: Control+1.5mx1.5m
T_{12}	F_4 S_3: Control+1.5mx1m

Table.3 Effect of N, P, K levels and plant densities on main vine length (m) in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	6.64	7.91	6.95	**7.16**
F_2	7.22	8.65	7.54	**7.80**
F_3	8.53	11.93	9.55	**10.00**
F_4	5.26	5.85	5.74	**5.62**
Mean	**6.91**	**8.58**	**7.45**	

	F	S	F x S
SEm	0.21	0.18	0.37
SEd±	0.30	0.26	0.52
CD at 5%	0.62	0.54	1.09

Nutrient combinations

F_1: 125:50:50 NPK Kg/ha

F_2: 150:60:60 NPK Kg/ha

F_3: 175:70:70 NPK Kg/ha

F_4: Control

Plant densities

S_1: 1m x1m

S_2: 1.5 m x 1.5m

S_3: 1.5m x 1m

Table.4 Effect of N, P, K levels and plant densities on number of nodes per vine in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	174.50	160.66	178.00	**173.05**
F_2	190.66	182.00.	205.33	**192.66**
F_3	189.00	177.66	198.00	**188.22**
F_4	158.33	157.00	163.00	**159.44**
Mean	**178.12**	**170.83**	**186.08**	

	F	S	F x S
SEm	2.60	2.25	4.51
SEd±	3.68	3.19	6.38
CD at 5%	7.64	6.62	N.S

Nutrient combinations

F_1: 125:50:50 NPK Kg/ha

F_2: 150:60:60 NPK Kg/ha

F_3: 175:70:70 NPK Kg/ha

F_4: Control

Plant densities

S_1: 1m x1m

S_2: 1.5 m x 1.5m

S_3: 1.5m x 1m

Table.5 Effect of N, P, K levels and plant densities on days taken to first harvest in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	107.4	97.66	85.36	**96.81**
F_2	88.49	83.11	63.46	**78.35**
F_3	98.98	93.03	83.76	**91.92**
F_4	119.35	120.55	118.00	**119.35**
Mean	**103.59**	**98.59**	**87.65**	

	F	S	F x S
SEm	1.80	1.56	3.13
SEd±	2.55	2.21	4.43
CD at 5%	5.30	4.59	9.19

Nutrient combinations

F_1: 125:50:50 NPK Kg/ha

F_2: 150:60:60 NPK Kg/ha

F_3: 175:70:70 NPK Kg/ha

F_4: Control

Plant densities

S_1: 1m x1m

S_2: 1.5 m x 1.5m

S_3: 1.5m x 1m

Table.6 Effect of N, P, K levels and plant densities on yield per vine (kg) in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	6.43	7.03	7.86	**7.10**
F_2	7.93	8.62	9.5	**8.68**
F_3	7.30	8.33	8.43	**8.02**
F_4	2.21	2.41	2.61	**2.43**
Mean	**5.96**	**6.59**	**7.11**	

	F	S	F x S
SEm	0.21	0.18	0.37
SEd±	0.30	0.26	0.53
CD at 5%	0.63	0.55	1.10

Nutrient combinations

F_1: 125:50:50 NPK Kg/ha

F_2: 150:60:60 NPK Kg/ha

F_3: 175:70:70 NPK Kg/ha

F_4: Control

Plant densities

S_1: 1m x1m

S_2: 1.5 m x 1.5m

S_3: 1.5m x 1m

Table.7 Effect of N, P, K levels and plant densities on yield per plot (kg) in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	40.86	44.3	55.13	**46.76**
F_2	49.43	52.40	67.90	**56.57**
F_3	44.00	49.86	61.70	**51.85**
F_4	13.50	13.60	13.90	**13.66**
Mean	**36.94**	**40.04**	**49.65**	

	F	S	F x S
SEm	1.44	1.25	2.51
SEd±	2.05	1.77	3.55
CD at 5%	4.25	3.68	7.36

Nutrient combinations

F_1: 125:50:50 NPK Kg/ha

F_2: 150:60:60 NPK Kg/ha

F_3: 175:70:70 NPK Kg/ha

F_4: Control

Plant densities

S_1: 1m x1m

S_2: 1.5 m x 1.5m

S_3: 1.5m x 1m

Table.8 Effect of N, P, K levels and plant densities on total yield (t ha^{-1}) in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	31.40	32.70	37.00	**33.70**
F_2	37.56	40.73	47.66	**41.98**
F_3	35.00	38.70	46.33	**40.01**
F_4	12.15	12.00	12.29	**12.14**
Mean	**24.61**	**26.53**	**29.60**	

	F	S	F x S
SEm	0.92	0.79	1.59
SEd±	1.30	1.12	2.25
CD at 5%	2.69	2.33	4.67

Nutrient combinations

F_1: 125:50:50 NPK Kg/ha

F_2: 150:60:60 NPK Kg/ha

F_3: 175:70:70 NPK Kg/ha

F_4: Control

Plant densities

S_1: 1m x1m

S_2: 1.5 m x 1.5m

S_3: 1.5m x 1m

Table.9 Effect of N, P, K levels and plant densities on reducing sugars (%) in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	1.67	1.82	1.78	**1.75**
F_2	2.40	2.91	2.88	**2.73**
F_3	2.13	2.40	2.21	**2.24**
F_4	1.64	1.70	1.66	**1.66**
Mean	**1.96**	**2.20**	**2.13**	

	F	S	F x S
SEm	0.02	0.02	0.04
SEd±	0.03	0.03	0.06
CD at 5%	0.07	0.06	0.13

Table.10 Effect of N, P, K levels and plant densities on total sugars (%) in pointed gourd (*Trichosanthes dioica* Roxb.)

	S_1	S_2	S_3	Mean
F_1	3.42	4.20	4.00	**3.87**
F_2	4.19	5.67	4.84	**4.90**
F_3	3.81	4.74	4.39	**4.31**
F_4	2.81	3.02	3.00	**2.95**
Mean	**3.56**	**4.40**	**4.05**	

	F	S	F x S
SEm	0.05	0.05	0.10
SEd±	0.08	0.07	0.14
CD at 5%	0.17	0.14	0.29

Nutrient combinations

F_1: 125:50:50 NPK Kg/ha

F_2: 150:60:60 NPK Kg/ha

F_3: 175:70:70 NPK Kg/ha

F_4: Control

Plant densities

S_1: 1m x1m

S_2: 1.5 m x 1.5m

S_3: 1.5m x 1m

Fig.1a Days taken for opening of first male flower

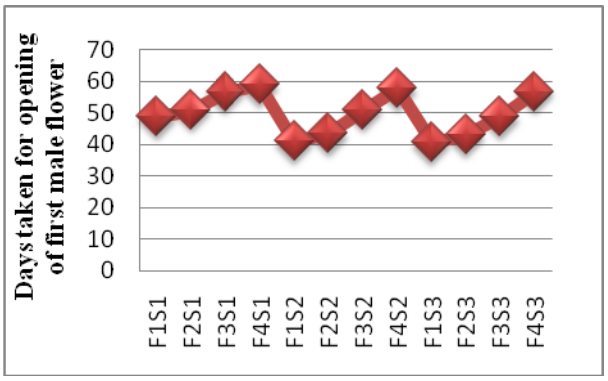


Fig.1b Days taken for opening of first female flower

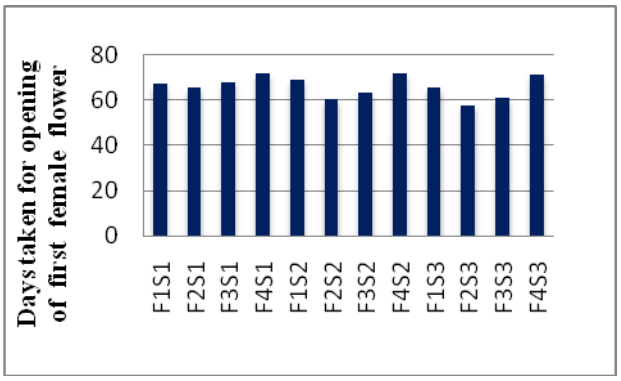


Fig.2 Effect of N, P, K levels and plant densities on number of fruits per vine in pointed gourd (*Trichosanthes dioica* Roxb.)

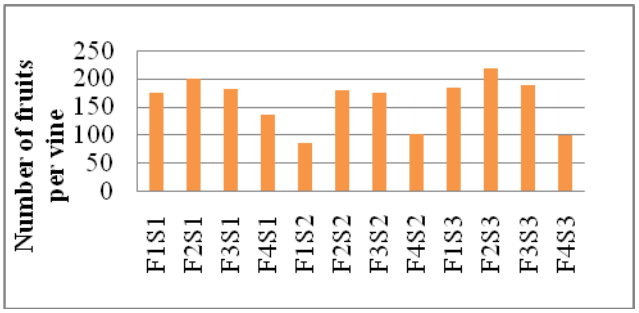


Fig.3 Effect of N, P, K levels and plant densities on weight of edible fruit (g), length of edible fruit (cm) and fruit diamter(cm) in pointed gourd (*Trichosanthes dioica* Roxb.)

Fig.3a Weight of edible fruit (g)

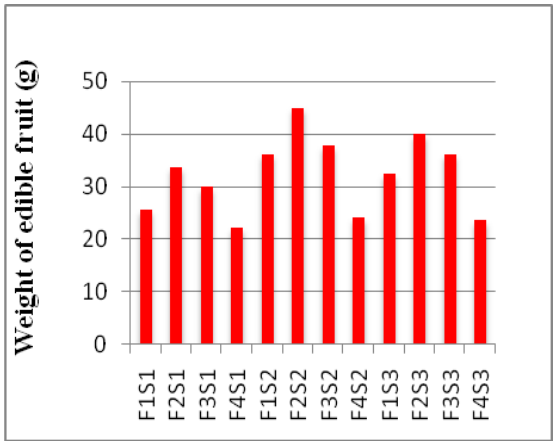


Fig.3a Length of edible fruit (cm)

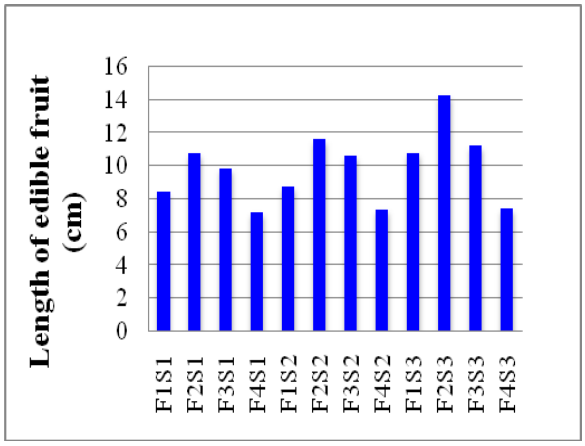


Fig.3c Fruit diameter (cm)

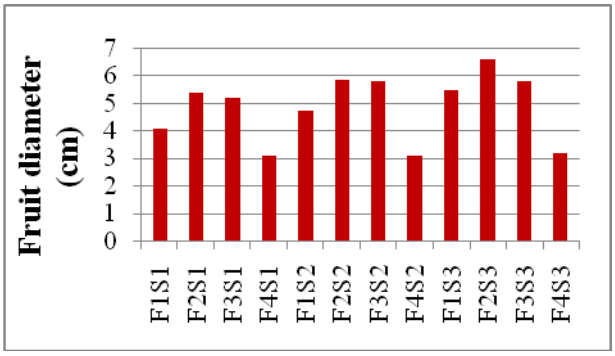


Fig.4 Effect of N, P, K levels and plant densities on total soluble solids (°Brix) in pointed gourd (*Trichosanthes dioica* Roxb.)

Fig.4a Ascorbic acid content (mg/100g)

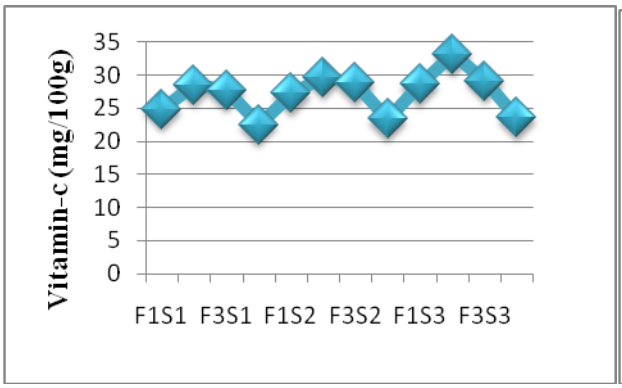


Fig.4b Protein content (g/100g)

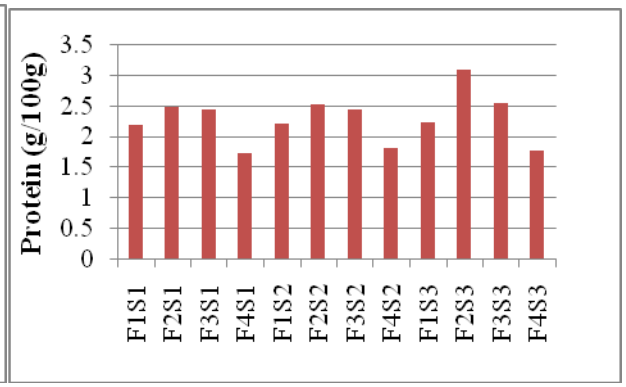
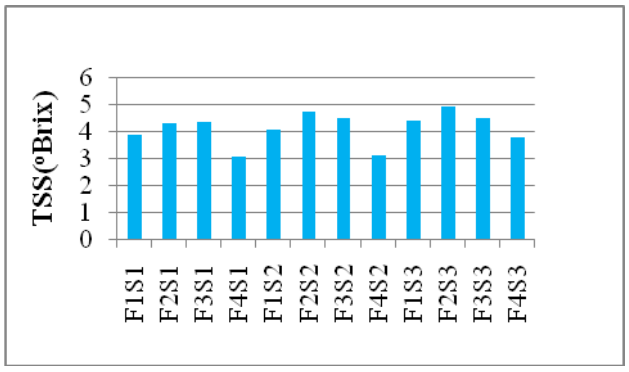


Fig.4c Total soluble solids (°Brix)



Protein content (g/100g)

Protein content was significantly influenced by the effect of N, P, K levels, plant densities and its interaction. Significantly maximum protein content (3.08 g) was noticed with the treatment combination of (T_6)-F_2S_3, followed by the treatment combination of (T_9)-F_3S_3 (2.55 g). Lowest protein content (1.72 g) was recorded with treatment (T_{10})-F_4S_1 (Fig. 4b). These results were in conformity with the findings of Shivashankaramurthy *et al.*, (2007) in gherkins.

Reducing sugars (%)

The N, P, K fertilizer level, plant densities and their interaction effects significantly influenced the reducing sugars. Higher reducing sugars (2.91 %) were recorded with the treatment combination of (T_5)-F_2S_2 followed by the treatment combination of (T_6)-F_2S_3 (2.88 %).

The lowest reducing sugars (1.64 %) were recorded with treatment (T_{10})-F_4S_1 (Table 9). The highest reducing sugars with (T_5)-F_2S_2 may be due to better translocation and accumulation of nutrients. These results were in conformity with the findings of Dimri and Lal (1988) in tomato.

Total sugars (%)

The interaction effect between N, P, K levels and plant densities on total sugars was found significant. The higher total sugars (5.67%) were recorded with the treatment combination of (T_5)-F_2S_2 followed by the treatment combination of (T_6)-F_2S_3 (4.84 %). The lowest total sugar (2.81%) was recorded treatment (T_{10})-F_4S_1 (Table 10). These results were in conformity with the findings of Dimri and Lal (1988) in tomato and Shivashankaramurthy *et al.*, (2007) in gherkins.

Total soluble solids (^{o}Brix)

Among different N, P, K fertilizer levels higher total soluble solids (4.67 ^{o}Brix) were recorded with F_2 followed by F_3 (4.47 ^{o}Brix) and the lower total soluble solids (3.31 ^{o}Brix) were recorded with F_4. These results were in conformity with the findings of Vishwakarma *et al.*, (2007) in spine gourd, Anjanappa *et al.*, (2012) in cucumber, Massri and Labban (2014) in water melon and Das *et al* (2015) in bottle gourd. These results were in conformity with the findings of Enas *et al.*, (2002). The interaction on total soluble solids due to combined influence of fertilizers and plant densities was non significant (Fig. 4c).

In conclusion, the present work is done with the objectives of to study the effect of N, P, K levels, plant densities and the interaction between N, P, K levels, plant densities on growth, yield and quality of pointed gourd. Among the treatment combinations of N,P,K levels and plant densities, the treatment combination (T_6)-F_2S_3: 150:60:60 NPK kg/ha + 1.5m x 1m recorded maximum values for growth, yield and quality parameters *viz.*, number of nodes per vine, number of primary branches per vine, number of fruits per vine, fruit length, fruit diameter, yield per vine, yield per plot, total yield, number of seeds per fruit, fruit retention percentage, ascorbic acid content, protein content and total soluble solids and the minimum values were recorded for the parameters node at which first male flower appeared, node at which first female flower appeared, days taken to first harvest and days taken from fruit set to marketable maturity. However, the application of (T_8)-F_3 S_2: 175:70:70 NPK Kg ha^{-1} + 1.5m x 1.5m recorded maximum main vine length and internodal length whereas (T_3)- F_1S_3: 125:50:50 NPK Kg ha^{-1} + 1.5m x 1m recorded minimum days taken for opening of first male flower and days taken for opening of first female flower. The application of (T_5)-

F_2S_2:150:60:60 NPK kg/ha + 1.5m x 1.5m recorded maximum weight of edible fruit, 100 seed weight, reducing sugars and total sugars.

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