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Effect of different fertigation levels of nitrogen, phosphorus and potassium on growth, yield and quality of pumpkin

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Abstract
An experiment was carried out during 2017-18 with the objectives to study the effect of different fertigation levels of nitrogen, phosphorus and potassium through fertigation on growth, yield and quality of pumpkin and to find out the suitable combination of nitrogen phosphorus and potassium fertigation levels for better growth, yield and quality of pumpkin. The experiment was laid out in Randomized Block design (RBD) with six treatments *viz.*, T1 50:25:00 NPK Kg ha^{-1}, T2 75:25:25 NPK Kg ha^{-1}, T3 100:50:25 NPK Kg ha^{-1}, T4 100:50:50 NPK Kg ha^{-1}, T5 125:50:50 NPK Kg ha^{-1} and T6 150:50:50 NPK Kg ha^{-1} replicated four times. The various growth parameters in respect to vine length (455.50 cm), number of branches (14.49), internodal length (16.53 cm), days required to bear 1st female flower (58.00 DAS) and female flowers per vine were significantly maximum in T4. As regard the yield and yield contributing parameters, number of fruits per vine (2.40), diameter of fruit (15.75 cm), thickness of flesh (2.78 cm), diameter of fruit cavity (11.62 cm), volume of fruit (789.73 cm3), yield per vine (10.68 kg), yield per plot (320.52 kg) and yield per hectare (203.50 q) were found significantly maximum in the T4.

Keywords: Fertigation, nitrogen, phosphorous, potassium, pumpkin, quality, yield

Introduction
Pumpkin (*Cucurbita moschata* Duch ex. Poir) is an important cucurbitaceous vegetable also called as Kashiphal, Sitaphal or Lalkaddu. Pumpkin is especially known for its low cost of production and long keeping quality. The fruits can be kept for several months. It is one of the very low-calorie vegetable that provide 26 calories from 100g and contains no saturated fats or cholesterol. However, it is rich in dietary fibre, Antioxidants, minerals, vitamins. It is one of the food items recommended by dieticians in cholesterol controlling and weight reduction programs. It is also a rich source of minerals like copper, calcium, potassium and phosphorus.
Fertigation is a new concept that is being adopted recently in several horticultural crops. Fertigation being relatively a new concept in Pumpkin, not many studies have been carried out. Thus, there is a need to standardize the fertigation technology of growing pumpkin. The application of nitrogen, phosphorous and potassium through fertigation improves the growth, quality and nutrient composition of the crop as well as enhancing the nutrient use efficiency minimize environmental pollution. Most of the growth characters like length of vine, branches per vine, length of internodes, number of fruits per vine, highest yield in F1 hybrids of pumpkin which increases with application of N, P and K in pumpkin.

Material and Methods
To identify the effect of different fertigation levels the experiment was conducted at Instructional farm, Department of Horticulture, Faculty of Horticulture and analytical work was carried out at, Analytical Laboratory, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2017-18. Akola is situated in subtropical region between 22.42°N latitude and 77.02° E longitude at an altitude of 307.42 m above the mean sea level. The climate of Akola is semi-arid and characterized by three distinct seasons *viz.*, hot and dry summer from March to May, warm and rainy monsoon from June to October and mild cold winter from November to February. The normal mean monthly maximum temperature is 10.60 °C min coldest December. The land used under the experimental layout was uniform with gentle slope. The soil was medium black with uniform in texture, colour and having good drainage.

Before laying out the experiment, initial soil samples were drawn at five randomly selected spots at a depth of 0-30 cm from the field and the composite samples were analyzed for physical and chemical characteristics as per the methods suggested against each parameter. Before layout of the experiment the soil recorded neutral pH of 7.3 and the content of available nitrogen, phosphorus and potassium levels were 182.15, 17.5 and 355.6 kg ha^{-1} respectively. Seeds of pumpkin (*Cucurbita moschata*) F1 Hybrid (Ankoor Bhim) were procured from local markets. Three seeds were sown 5 cm apart in triangular fashion, and were dibbled at 2 cm depth near each dripper at a distance of 2.5 m x 1.5 m.

The plants are treated with six different fertigation levels as follows T1 - 50:25:00 kg NPK, T2 - 75:25:25 kg NPK, T3 - 100:50:25 kg NPK, T4 - 100:50:50 kg NPK, T5 - 125:50:50 kg NPK, T6 - 150:50:50 kg NPK. Nitrogen was given at 4 days interval i.e., 15 splits. (From 8th DAS to 60th DAS). Potassium and Phosphorus was given at 8 days interval i.e., 12 splits. (From 8th DAS to 96th DAS). The experiment was conducted in Randomized Block Design with 4 replication and 6 treatments. Fruits were harvested after they were fully matured and have attended complete size (about 3-5 kg fruit size and they have attractive dark green to yellow colour with white stripes all over the fruit.

Results and Discussion

Vine length (Table 1) was finally recorded at 90 DAS maximum vine length (455.5 cm) was recorded in the treatment T4 (100:50:50 kg $^{ha-1}$ NPK) which was significantly superior over other treatments. Whereas the minimum vine length (321.38 cm) was observed in T1. Maximum length of pumpkin vine was obtained in treatment T4 might be due to the moderate level of fertigation. Nitrogen which is major component of protoplasm, helps in photosynthesis and enhances metabolic rate, cell division and cell elongation, which allow the plant grow faster. Phosphorus enhances the elongation, leaf expansion and helps in cell elongation. Deshi *et al*., (1966) [4] found similar results in bitter gourd, Randhawa *et al*., (1981) [20] in muskmelon, Suresh and Pappiah (1991) [26] in bitter gourd and, Agba and Enya (2006) [2] in cucumber.

In respect of internodal length (Table 1) recorded at 90 DAS; the maximum internodal length (16.53 cm) was recorded in the treatment T4 (100:50:50 kg ha^{-1} NPK) which was at par with treatment T3 (16.20cm). Whereas the minimum internodal length (14.64cm) was registered in Treatment T1. The maximum length of internodes was observed in the treatment T4. That might be attributed due to the effect of nitrogen, which was readily available to plant, abundant supply of available nutrient from soil, with comparatively lesser retention in roots and more translocations to the aerial parts for protoplasmic protein and synthesis of other compounds. Oloyede *et al*., (2013) [17] in pumpkin observed similar results and Randhawa *et al*. (1981) [20] recorded similar results in muskmelon.

The maximum number of branches (Table 1) recorded in a treatment T4 (100:50:50 kg ha-1 NPK) with application of nitrogen caused a significant enhancement in number of branches per vine. This shows, as NPK fertigation increases up to certain levels, the vegetative growth in terms of number of branches of pumpkin increased. This might be due to change in synthesis of NAA and other compounds as results of N and P. Similar result also obtained by Randhawa *et al*. (1981) [20] recorded similar results in muskmelon, Samdyan *et al*., (1992) [22] recoded similar results in bitter gourd, Phu (1997) [18] reported same kind of results in cucumber and Mostafa *et al*., (2014) [12] in cucumber showed similar results.

Number of male flower (Table 2) per vine (53.81) was found significantly minimum in treatment T1 (50:20:00 kg ha^{-1} NPK). Whereas maximum number of male flowers per vine (80.80) was found in treatment T6. Maximum number of female flower (Table 2) per vine (8.58) were found in treatment T4 (100:50:50 kg ha^{-1} NPK) which was found to be at par with treatments T5 (7.97) and T6 (7.94) while minimum number of female flowers per vine (6.24) were observed in treatment T1. From (Table 2) sex ratio (7.84) was minimum in treatment T4 (100:50:50 kg ha^{-1} NPK) might be due effect to fertigation. Although a plant receiving a lot of nitrogen has a plethora of new, leafy foliage, there is often only foliage. It is difficult for fruit and flowers to grow when there is too much nitrogen in the soil while flower buds fall off or are disfigured if they do bloom. In case of male flowers per vine, NPK at increasing levels increases male flower. The modification of sex ratio in favour of female flowers using mineral nutrients, especially high level of nitrogen influences sex expression, Oloyede *et al*., (2013) [17] in case of male flowers reported that NPK at increasing levels increases male flower. Similar results were found by Manuca (1989) [9] in bitter gourd, Meenakshi, *et al*., (2002) [10] in bitter gourd and Maluki *et al*., (2016) [8] in watermelon.

The treatment T4 (100:50:50 kg ha^{-1} NPK) produced significantly maximum number of fruits (Table 2) per vine (2.48) which was found to be at par with treatment T3 (2.40) and T2 (2.06). The minimum number of fruits per vine (1.41) was recorded in Treatment T6. The maximum number of fruits were observed in treatment T4 with NPK fertigation level of 100:50:50 kg ha^{-1}. This might be due to application of potassium, which increases female flowers and subsequently enhances fruit yield. Jilani *et al*., (2009) [7] in cucumber, Muhammad Saleem *et al*., (2009) [13] observed similar results in cucumber and Islam (1995) [6] in bitter gourd reported similar results.

The maximum average weight (Table 2) of fruit (4.41 kg) was recorded in treatment T5 (125:50:50 kg ha^{-1} NPK) which was found to be at par with treatment T4 (4.30 kg). While the minimum weight of fruit (3.35 kg) was recorded in Treatment T1. The maximum weight of fruit (4.41 kg) was observed in treatment T5 which was having fertigation level of 100:50:50 kg ha^{-1}. This might be due to application of potassium through fertigation, which helps in osmoregulation and cell extension, stomatal movement, activation of enzymes and photosynthesis. Also, application of nitrogen helps uptake of phosphorus. Similar results were found, Ahmed *et al*., (2007) [3] in cucumber and Oloyede *et al*., (2013) [17], in pumpkin, Munir *et al*., (2004) [14] in squash. Adeyeye *et al*., (2016) [1] in watermelon.

Treatment T4 recorded maximum diameter (Table 2) of fruit (15.75 cm), which was found to be at par with treatment T5 (15.00 cm) while treatment T1 was observed with minimum diameter of fruit (10.84 cm). This might be due to nitrogen, phosphorous and potassium influences fruit parameters and plays an important role in cell division, and fruit development. Sanap *et al*., (2010) [23] reported significant effect of different levels.

In respect to thickness of flesh (Table 2), it showed significant influence over different levels of fertigation. The treatment T4 recorded maximum thickness of flesh (2.78 cm) whereas minimum thickness of flesh (1.93 cm) was recorded in the

treatment T1. NPK is increasing meristemic activities, which can produce photosynthetic products, accumulation required for fruits formation, development and subsequently on thickness of flesh. Also application of potassium increases thickness of flesh. Manuca (1989) [9] found similar results in cucumber and Adeyeye *et al*., (2016) [1] in watermelon.

Regarding yield (Table 2) per hectare, maximum yield (203.50 q) was observed in treatment T4 (100:50:50 NPK kg ha^{-1}) which was at par with treatment T3 while minimum yield per hectare (105.12 q) was found to be in treatment T1. Nitrogen related with high photosynthetic activity dark green colour vigorous growth more number of branches which results in more number of biomass of vine and size enlargement. While phosphorus improves quality of fruits. It plays an important role in cell division, and fruit development and potassium help in transportation of prepared food from leaves to the rest of the plant parts such as fruits, which results in increase in yield. In regards with treatment T5 and T6 the yield was comparatively less, although with increasing nitrogen levels. This might be due to excessive application of nitrogen the vines mostly produced a dark green foliage and less reproductive organs. Excessive N (large amount of N combination with small accounts of P, K) causes increased incidences of viral pests like cucumber mosaic virus (CMV) which resulted severely stunted and fruits become distorted and are small in size and fruits are often discoloured. Similar, Oloyede *et al*., (2013) [17] reported significant effect of different levels of fertigation on yield of pumpkin fruit. Hari *et al*., (2016) [5] found similar results in bitter gourd and Sajjan *et al*., (2009) [21] obtained similar results in pumpkin. Manuca *et al*., (2017) reported significantly high yield of pumpkin fruit.

The maximum (Table 2) TSS (12.54 °B) was recorded in the treatment T1 (50:25:00 kg ha^{-1} NPK) which were found at par with treatment T2, T4 and treatment T3. The minimum TSS (10.25 °B) was recorded in the treatment T6. The results of present investigation agree with the finding of Meenakshi *et al*., (2007) [11] in bitter gourd and Sumathi *et al*., (2011) [25] in cucumber. Ohashi *et al*., in muskmelon.

Table 1: Effect of different fertigation levels on growth parameters of pumpkin

	Length of vine (cm)			Internodal Length (Cm)			No. Of Branches Per Vine		
Treatment	**30 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**
T_1- 50:25:00	13.38	13.38	13.38	1.88	10.72	14.64	0.94	8.95	11.65
T_2- 75:25:25	15.16	15.16	15.16	2.37	11.10	14.86	1.33	9.93	12.81
T_3-100:50:25	17.89	17.89	17.89	2.44	11.27	16.20	1.24	10.76	13.92
T_4- 100:50:50	20.08	20.08	20.08	3.58	11.53	16.53	1.57	11.07	14.49
T_5- 125:50:50	18.51	18.51	18.51	3.50	11.35	14.93	1.35	10.79	13.84
T_6- 150:50:50	18.70	18.70	18.70	3.12	11.12	14.98	1.38	10.78	13.80
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.32	0.32	0.32	0.16	0.14	0.20	0.09	0.19	0.24
C.D. at 5%	0.95	0.95	0.95	0.47	0.42	0.61	0.27	0.57	0.71

Table 2: Effect of different fertigation levels on growth, yield and quality parameters of pumpkin

	No. Male and female flowers per vine			No. Of fruits	Wt. Of	Diameter of fruit	Thickness of flesh	Yield per ha	TSS
Treatment	**Male**	**Female**	**Ratio**	**per vine**	**fruits (kg)**	**(cm)**	**(cm)**	**(q)**	**(°B)**
T_1- 50:25:00	53.81	6.24	8.62	1.66	3.35	10.84	1.93	105.12	12.54
T_2- 75:25:25	56.24	6.62	8.49	2.06	3.68	13.33	2.27	144.39	12.49
T_3-100:50:25	62.20	7.68	8.09	2.40	3.96	14.27	2.07	181.42	12.45
T_4- 100:50:50	67.24	8.58	7.83	2.48	4.30	15.75	2.78	203.50	12.45
T_5- 125:50:50	76.69	7.97	9.62	1.45	4.41	15.00	2.36	128.09	10.35
T_6- 150:50:50	80.80	7.94	10.17	1.41	4.07	13.71	2.36	121.17	10.25
'F' test	Sig	Sig		Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.49	0.15		0.15	0.10	0.26	0.12	12.61	0.38
C.D. at 5%	1.49	0.46		0.46	0.30	0.80	0.37	38.02	1.15

Conclusions

Based on the present findings, it can be concluded that, different fertigation levels had significantly influenced the growth, yield and quality parameters of pumpkin. The fertigation level of 100:50:50 kg NPK ha^{-1} i.e., treatment T4 was found significantly superior than other treatments with respect to maximum values for length of vine, number of branches and length of internodes, appearance of first female flower, number of male and female flowers and sex ratio. As regards to, yield parameters number of fruits per vine, diameter of fruit, thickness of fruit, thickness of flesh, volume of fruit, yield per vine, yield per plot and yield per hectare was found to be significantly maximum in treatment T4 (100:50:50 kg ha^{-1}) which was found to be at par with treatment T3 (100:50:25 kg ha^{-1}). The weight of fruit was significantly maximum in treatment T5 which was having fertigation level of 125:50:50 kg ha^{-1}. TSS of fruit was found significantly maximum in treatment T1 which had fertigation level of nitrogen, phosphorous and potassium at 50:25:00 kg ha^{-1}. Application of more nitrogen does not significantly show any increase in growth, yield and quality of pumpkin as observed in treatment T5 and T6.

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