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EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM ON GROWTH AND YIELD OF ARVI (*Colocasia esculenta* L.) CV. VALLABH HANS

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ABSTRACT : An investigation entitled "Effect of nitrogen, phosphorus and potassium on growth and yield of Arvi (*Colocasia esculenta* L.)" was carried out at Horticulture Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during 2017-18 in Randomized Block Design (RBD) with three replications. Total ten treatment *viz.* T_1- NPK 60:30:80 kg ha^{-1},T_2- NPK 60 :60:120 kg ha^{-1}, T_3-NPK 60 :90:160 kg ha^{-1} , T_4- NPK 90:30:80 kg ha^{-1}, T_5-NPK 90:60:120 kg ha^{-1}, T_6-NPK 90:90:160 kg ha^{-1}, T_7-NPK 120:30:80 kg ha^{-1}, T_8-NPK 120:60:120 kg ha^{-1}, T_9-NPK 120:90:160 kg ha^{-1} and T_{10}- Control were tried to assess the impact of nitrogen, phosphorous and potassium on growth and yield of colocasia during investigation. Out of these, the treatment with NPK 120:30:80 was found significantly superior in terms of plant height (cm.), plant spread (cm), number of leaves plant^{-1}, number of tillers plant^{-1}, girth of pseudostem from ground level (cm) , length of leaf (cm), width of leaf (cm), petiole length (cm) and petiole breadth (cm). Similarly, yield and yield attributing parameters *i.e.,* number of corms plant^{-1} , corm length (cm), corm girth (cm), weight of corm (g), corm yield plant^{-1} (g), and corm yield (q ha^{-1}) were found significantly superior with the application of NPK 120:30:80 as compared to control and other treatments. Finally, a dose of NPK @ 120:30:80 kg ha^{-1} gave the highest yield of corm *i.e.,* 289.83 q ha^{-1}, whereas lowest yield of corm *i.e.,* 92.25 q ha^{-1} was observed under control during the cropping period.

Keywords : *Nitrogen, phosphorous, potassium, Colocasia cv. Vallabh Hans.*

Arvi (*Colocasia esculenta* L.) is a tuber vegetable crop belongs to the monocotyledon class of family Araceae. It is also called edible *Arum* or *Taro*. The family Araceae contains about 100 genera and 1500 widely distributed species (Vinning., 24). *Arvi* is characterized by the possession of a large cylindrical central corm and very few cormels. It is referred agronomically as the *dasheen* type of arvi. It have been found in diploid (2n = 28) and triploid (3n=42) form. The high fertility is found in diploid ones, while triploids are highly sterile (Jos and Vijaya Bai, 11). Plants are perennial but cultivated as annuals, lactiferous and very variable herb with 30-150 cm in height. Leaves are large or rather large, obliquely erect, long petioles, with varying colour and size. Petiole is sheathering at the base, uniformly light or dark green, green with dark streaks or violet, 40-150 cm long. It consists mainly of the leaves with long petiole, which arises in a whorl from the apex of the underground corm. Corms are cylindrical with short internodes and few side tubers.

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India occupies a prime position in the world in orientation to vegetable production. India is the second largest producer of vegetables next to China. The area under vegetable production is 10238 thousand hectares with 178172 thousand metric tonnes an annual production of vegetables during 2016-17. Uttar Pradesh has the first rank in area and production *i.e.,* 1439.70 thousand hectare and 28192.63 thousand metric tonnes, respectively (Anon., 2). Arvi serves as staple food of diet for people around the world and it is the fourteenth most consumable vegetable in worldwide (Rao *et al..,* 18). Arvi is mainly cultivated for its edible root stock, but the leaves and its young stalk are also cooked and used as leafy vegetables. Arvi stock is used as food and prepared the dishes just like potatoes. The main economic parts in arvi are the corms and cormels as well as the green tender leaves. The corm of Colocasia is rich in starch and minerals. It has high medicinal value and included in many Ayurvedic preparations (Thankappan, 21). Colocasia is known for its high nutritive values particularly rich in carbohydrate, protein, vitamin C and certain other

constituents. It is mainly used as food, in some countries it is used for making fermented products. Taro flour is used as baby food and also used for making chips. The acridity of tubers and leaves is due to presence of calcium oxalate. Calcium oxalate content in tubers/corm and the leaves vary from crop to crop and variety to variety (Ashokan *et al.,* 3). The corm is an excellent source of carbohydrate, the majority being starch of which 17-28% is amylase and the remainder is amylo-pectin. Various parts of the plant are also used in traditional medicine practice (Tsitsiringos, 22). Arvi is a versatile crop grown under puddle low land areas and under dry or irrigated upland conditions. It is grown as a pure crop or as an intercrop in different cropping systems. Its ability to tolerate salinity makes it suitable for localities, where very few other crops are grown (Grubben and Denton, 8).

Nitrogen is mainly responsible for promoting the growth of crops and largely used in the synthesis of proteins in plant body. It is also a part of the chlorophyll molecule. Nitrogen is responsible for manufacturing protein, carbohydrates, mineral matter in colocasia.

Phosphorus plays an important role in structural components of the cell and plays an important role in energy transformation and metabolic process of plant. Potassium is essential for carbohydrate translocation from tops to roots. It plays a major role in the production of corms. Hence, it is necessary for enhancing the corm yield and yield attributes. To improve the yield and quality of arvi, there is a need to standardize the optimum dose of nutrients for improving the physico-chemical properties of soil as well as yield and quality of produce.

MATERIALS AND METHODS

The present field experiment was conducted at Horticulture Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during the year 2017-18 on "Effect of nitrogen, phosphorus and potassium on growth and yield of Arvi (*Colocasia esculenta* L)". The maximum temperature ranges from 40 to 45°C during summer, while minimum ranges from 7 to 8 °C during winter. The frost was occasionally occurred in month of December-February. The various physical and chemical properties were analyzed from the soil sample obtained from the experimental field. The soil of experimental plot was sandy loam in texture with a pH 7.75. The organic carbon of experimental soil was 0.41%. The available nitrogen, phosphorous and potassium were determined *i.e.,* 158.98, 22.18 and 114.80 kg ha^{-1}, respectively. The EC of soil is 0.25 ds/m^{-1} (Jackson 10, Total ten treatments viz. T_1- NPK 60:30:80 kg ha^{-1},T_2- NPK 60 :60:120 kg ha^{-1}, T_3-NPK 60 :90:160 kg ha^{-1} , T_4- NPK 90:30:80 kg ha^{-1}, T_5-NPK 90:60:120 kg ha^{-1}, T_6-NPK 90:90:160 kg ha^{-1}, T_7-NPK 120:30:80 kg ha^{-1}, T_8-NPK 120:60:120 kg ha^{-1}, T_9-NPK 120:90:160 kg ha^{-1} and T_{10}- Control were applied in Randomized Block Design (RBD) with three replication. The experimental field was thoroughly prepared by using repeated ploughing by tractor driven implements like harrow and cultivator followed by planking. After that, a scientific layout plan was made with making ridges and furrows for planting purpose. Vallabh Hans variety of colocasia was taken for the present investigation and evolved by locally available germplasm during 2014 and released by Department of Horticulture, SVPUAT, Meerut and recommends for commercial cultivation for western plain zones of Uttar Pradesh. The seed corm of Vallabh Hans were treated with fungicidal solution of carbendazim @ 2g per litre of water and dried in shade to overcome the incidence corm rot. Thereafter, corms were planted on the ridges at a 40 $\times$ 30 cm planting distance during second fortnight of March, 2017. At the time of planting, a basal dose of well rotten FYM @ 20 tons per hectare was applied in experimental plot prior to two week of planting. The full dose of phosphorous, potassium and half dose of nitrogen were applied at time of planting of seed corm. The remaining dose of nitrogen was applied in each plot as per treatment in two spilt doses as top dressing at 30 and 60 days of planting (DAP). The irrigation schedule was maintained by the irrigational intervals at 10-15 days intervals in furrows upto a height 2/3rd. The earthing up was done followed by weeding and hoeing during the crop growth by manual means to check the weed growth, nutrient loss and to make the soil friable. The various plant protection measures were followed to up keep the crop healthy by using fungicides and insecticides to reduce the infestation of insect-pest and diseases.

Five plants were tagged in each plot randomly and used for further investigation. The various observations on growth yield and yield attributing parameters were recorded during course of investigation. Finally, field data were collected and statistically analyzed with using standard method as suggested by Gomez and Gomez (7).

RESULTS AND DISCUSSION

An attempt has been made to review results and discussion on various growth, yield and yield attributing characters as affected by various doses of nitrogen, phosphorous and potassium of Arvi during the course

of investigation. The details of results and discussion are given below with using earlier findings of other workers.

Effect of NPK doses on various growth parameters

Experimental findings exhibited in Table-1 on various growth parameters in terms of the height of plant and spread of plant were significantly influenced by the various doses of nitrogen, phosphorous and potassium in increasing trend as compared to control. It was observed that the application NPK doses upto120:30:80 NPK kg ha^{-1} was gave maximum plant height, then slightly decreased the plant height with further higher doses of NPK at harvesting. The maximum plant height (39.10 cm) was recorded with the application @ 120:30:80 NPK kg ha^{-1}, whereas the minimum plant height was observed with control 25.93. Similarly, the maximum plant spread (74.20 cm) was recorded with an application of 120:30:80 NPK kg ha^{-1}, while the minimum plant spread (53.30 cm) was observed with unfertilized plot at harvest after planting. The plant height was significantly higher with application @ 120:30:80NPK kg ha^{-1} and therefore, it may be due to the sufficient amount nutrients supplied to the plant resulting good growth of plant height continuously upto harvesting. Similar finding were also earlier reported by (Mojtaba *et al.,* 13). The variation in plant spread might be due to differential growth habit of cultivars under congenial growing conditions in optimum level of nitrogen, phosphorous and potassium application and plant spread was greatly influenced, it is an indicator to increase the corm size and weight. These results were close conformity with findings of Anil *et al.* (1).

In other hand, the data reflected that the various levels of NPK doses significantly improves the counts of green leaves plant^{-1} and number of tillers plant^{-1} upto NPK was applied @120:30:80 NPK kg ha^{-1} as compared to control. It was also noted that number of leaves plant^{-1} were markedly decreased with further increment in NPK doses at harvesting. The maximum number of leaves plant^{-1} (5.36) and numbers of tillers (4.70) were observed with an application 120:30:80 NPK Kg ha^{-1}, whereas the minimum leaves plant^{-1} (3.92) and numbers of tillers (2.40) were noted under control at harvesting. A comparative examination of number of leaves plant^{-1} and numbers of tillers indicated these counts being lesser with lower nutrient doses as compared to higher nutrient doses. Increasing of N, P and K fertilization levels had a stimulative effect on all vegetative growth. The obtained results were close in conformity with findings of Awad *et al.* (4) and Verma *et al.* (23). Moreover, the maximum girth of pseudostem (8.77 cm) was recorded in with an application of 120:30:80 NPK kg ha^{-1} , whereas the minimum girth of pseudostem was recorded under control *i.e.,* 5.98 cm. It might be due to the positive response in cell multiplication and photosynthesis which give rise to increase in the size of the stem horizontal manner. The above findings are

Table 1: Effect of nitrogen, phosphorus and potassium on growth attributing parameters of Arvi (*Colocasia esculenta* L).

Treatments	Plant height at harvest (cm)	Plant spread at harvest (cm)	No.of leaves at harvest	No. of tillers plant^{-1}	Girth of pseudo stem (cm)	Length of leaf (cm)	Width of leaf of crop (cm)	Petiole length of crop (cm)	Breadth of petiole (cm)
T_1-60:30:80 NPK kg ha^{-1}	27.83	55.90	4.34	2.50	6.32	21.05	16.75	12.82	2.93
T_2-60 :60:120 NPK kg ha^{-1}	29.13	59.20	4.37	2.80	6.88	21.75	18.07	13.78	2.81
T_3-60 :90:160 NPK kg ha^{-1}	31.07	63.00	4.59	3.10	7.51	22.51	19.87	15.18	3.42
T_4-90:30:80 NPK kg ha^{-1}	32.53	65.60	4.91	3.40	7.91	23.71	20.64	16.27	3.59
T_5-90:60:120 NPK kg ha^{-1}	34.30	68.53	5.14	3.70	8.24	25.06	21.80	17.07	3.74
T_6-90:90:160 NPK kg ha^{-1}	35.53	72.13	5.01	3.90	8.44	25.62	22.00	18.44	3.82
T_7-120:30:80 NPK kg ha^{1}	39.10	74.20	5.36	4.70	8.77	26.92	23.03	19.67	3.87
T_8-120:60:120 NPK kg ha^{-1}	35.97	72.27	4.87	4.50	8.67	25.06	21.80	18.47	3.78
T_9-120:90:160 NPK kg ha^{-1}	33.73	69.20	4.89	4.30	8.59	24.32	21.40	17.24	3.68
T_{10}- Control	25.93	53.30	3.92	2.40	5.98	20.76	16.65	12.67	2.29
C.D. (P=0.05)	**1.16**	**1.56**	**0.42**	**0.36**	**0.48**	**1.8**	**2.33**	**0.85**	**0.37**

close in conformity with earlier results of Sen *et al.* (20) and Mengel and Kirkby (12).

An assessment of data presented in Table-1 showed that the different levels of nitrogen, phosphorous and potassium application had gave the noteworthy effect on width of leaf and length of leaf at mid season stage of crop up to a most favourable level *i.e.,* 120:30:80 NPK kg ha^{-1} and further decreased the width of leaf with each increment in NPK doses as compared to control and other lower levels of NPK ha^{-1} during the experimentation. The maximum length of leaf (26.92cm) and width of leaf (23.03 cm) were recorded with an application of @120:30:80 NPK kg ha^{-1}, while it was found minimum length and width of leaf *i.e.,* 20.76 cm and 16.65 cm, respectively under control (T_{10}). The leaf length and width of leaves were more due to the higher levels of NPK in leaf area which enhances the protein synthesis which allows the plant to grow faster and stimulates apical growth as well as increases leaf size in terms of length and width. It was also found that cell multiplication and photosynthesis rates increased positive manner resulting, rise to increase in the size of the leaves when applied nitrogen, phosphorous and potassium at optimum level. The favourable response also confirmed the essentiality of N, P and K in plant growth and development (Mengel and Kirkby, 12; and Ayoola and Makinde, 5). The maximum petiole length (19.67 cm) and width (3.87 cm) were observed with an application of 120:30:80 NPK kg ha^{-1}, whereas the minimum petiole length (12.67 cm) and width (2.29 cm) were examined under control. The length and breadth of petiole significantly affected by various levels of nitrogen, phosphorous and potassium at mid season stage of crop and observed that petiole length and breadth were significantly improved upto a dose of NPK @ 120:30:80 kg ha^{-1}, while, it was slightly reduced the petiole length with further increment in nourishment doses during cropping season. The increase in petiole length and breadth with increasing levels of fertilizer had an encouraging effect on vegetative augmentation as it forms an important part of chlorophyll, proteins and amino acids. This might had reflected in better photosynthesis which promotes growth. Application of potassium has been found to reduce the fixation of NH_4^+ and thereby increase the utilization of nitrogen by growing plants. For this reason, increase in vegetative growth was more pronounced at the higher level of nitrogen application. The results are in accordance with the findings of Ismail and Zinda (9).

Effect of NPK doses on yield and yield attributing parameters

Data pertaining from the Table 2 exhibited that the all yield attributing parameters had gave optimistic behavior as influenced by various doses of nitrogen and phosphorous, potassium as compared to control and other treatments during the course of study. It was also reported that the yield and attributing parameters were found superior upto a dose of 120:30:80 NPK kg ha^{-1}. Furthermore, these were to some extent decreased with all higher doses of nitrogen, phosphorous and potassium. The greatest numbers of corms $plant^{-1}$ (12.70) were counted with an application 120:30:80 NPK kg ha^{-1}, whereas the minimum number

Table 2 : Effect of nitrogen, phosphorus and potassium on yield and yield attributing parameters of Arvi (*Colocasia esculenta* L).

Treatments	No. of corms $plant^{-1}$	Corm length (cm)	Corm girth (cm)	Weight of corm (g)	Yield of corm $plant^{-1}$ (g)	Yield of corms (q/ha)
T_1-60:30:80 NPK kg ha^{-1}	7.40	4.10	7.50	18.10	133.92	111.59
T_2-60 :60:120 NPK kg ha^{-1}	8.10	4.40	8.30	19.80	160.45	133.71
T_3-60 :90:160 NPK kg ha^{-1}	8.70	4.90	8.80	20.70	180.14	150.11
T_4-90:30:80 NPK kg ha^{-1}	9.30	5.20	9.30	22.40	208.53	173.77
T_5-90:60:120 NPK kg ha^{-1}	9.80	5.80	9.60	23.20	227.29	189.40
T_6-90:90:160 NPK kg ha^{-1}	10.40	6.30	10.20	24.10	264.52	220.42
T_7-120:30:80 NPK kg ha^{1}	12.70	7.10	11.60	27.40	347.80	289.83
T_8-120:60:120 NPK kg ha^{-1}	11.30	6.10	10.80	26.20	296.05	275.05
T_9-120:90:160 NPK kg ha^{-1}	10.90	5.50	9.90	24.70	290.06	246.70
T_{10}- Control	6.80	3.60	6.40	16.30	110.71	92.25
C.D. (P=0.05)	**0.63**	**0.63**	**0.53**	**0.93**	**20.68**	**32.17**

of corms plant^{-1} (6.80) were found in T_{10}- control. It capacity be due to the synthesis of protein and carbohydrate by nitrogen and phosphorous increases the growth of roots, however potassium helps to translocation of food substance from top to the roots favoured the numbers of corm plant^{-1}. Similar findings were in advance reported by Neduchezhiyan *et al.* (14), Ram Batuk *et al.* (17) and Rajeswari *et al.* (16).

In context of length and girth of corm, the maximum length (7.10 cm) and girth (11.60 cm) were examined in a dose of 120:30:80 NPK kg ha^{-1} (T_7), whereas the minimum length (3.60 cm) and girth (6.40 cm) of corm were noticed under T_{10}- control. It might be due formation of protein and carbohydrate as a result of high-quality uptake of nitrogen and phosphorous increases the development of roots, however potassium helps to translocation of food stuff from leaves in to the roots prolonged length and girth of corms. Similar results were obtained by Chattopadhyay *et al.* (6) and Nedunchezhiyan *et al.* (14).

The data exhibited that the different levels of nitrogen, phosphorous and potassium significantly improved the weight of corm with each increment in NPK dose upto T_7-120:30:80 kg ha^{-1} as compared to control and other treatments. It was also noticed that additional increment in NPK levels gave a disadvantageous effect on corm weight. The maximum weight of corm (27.40 g) was recorded in with an application of 120:30:80 NPK kg ha^{-1} (T_7), therefore, the minimum weight of corm (16.30 g) was recorded in control (T_{10}). The corm weight was noticed in higher side due to the higher gathering of protein and carbohydrates and assimilation of photosynthates by the optimum level of nitrogen, phosphorous and potassium in colocasia. These findings are closely related with earlier results obtained by Ismail and Zinda (9) and Ogbonna and Nweze (15).

The data observed on yield of corm plant-1 showed that the utmost yield of corm plant-1 (347.80 g) was recorded with a dose @ 120:30:80 NPK kg ha^{-1}, whereas the minimum yield of corm plant^{-1} (110.71g) was intended in unfertilized plot (control). Similarly, the greatest yield of corms *i.e.,* 289.83q ha^{-1} was obtained with an application 120:30:80 NPK kg ha^{-1} followed by T_8-120:60:120 NPK kg ha^{-1} (275.05 q ha^{-1}). However, minimum yield of corms (92.25q ha^{-1}) was recorded under control followed by T_1-60:30:80 NPK kg ha^{-1} (111.59 q ha^{-1}) during growing season. This is might be due to the colocasia plant manufactures the plentiful quantity of carbohydrate and minerals in corm, consequential increase the number of corm and phosphorous responsible for swift growth of plants. Similarly potassium responsible for translocation of protein and carbohydrates to form more number of corms. Due to this, more yields obtained from plants. It leads to increase the yield due to the maximum uptake of nitrogen, phosphorous and potassium comfortable by the plants to buildup of carbohydrates, proteins and minerals. The chlorophyll II, translocation of these manufactures material from plant body to productive organs of plants like corm, resulting significant yield was experienced. The data is in accordance with Salam *et al.* (19), Ismail and Zinda (9), Ogbonna and Nweze (15) and Rajeswari *et al.* (16).

CONCLUSION

Based on above results and discussion of the present study, an application of 120:30:80 NPK kg ha^{-1} was found most appropriate in terms of growth and yield of Arvi corms. Furthermore, it can be suggested that farmers of western plain zone of UP get maximum production of Arvi with new recommended dose of nitrogen, phosphorous and potassium.

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