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Quantitative analysis of radioactive waste and its effect on soil and vegetable crops

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Abstract

In the present research paper effect on the growth and phosphorus absorption in different part of the vegetable crops viz., seedling, flowering and harvesting (fruit/vegetable) stages was studied in water culture, pot culture experiment was carried out in august 2023- december 2023 with four levels of phosphorus using P^{32} tagged super phosphate viz., 0.0, 0.5, 1.0, 1.50, gm $P_2O_5/35$ cm (Pot), respectively. A uniform doses of recommended N & K were applied along with uptake of utilization of applied fertilizer as Phosphorus treatment in dark clay of Moradabad Distt. U.P. in India. An increase in the phosphorus of the absorbed phosphorus trans-located to the short and the reduction of root weight were the most consistent symptoms. Dry matter yield, total uptake of phosphorus and percentage of P^{32} derived from fertilizer increased significantly with increasing level of phosphorus. But percentage utilization of added phosphorus showed a reverse trend at all the stages of vegetable crops growth. Harvesting (fruit/vegetable) yield increased significantly with increasing phosphorus levels in all three vegetable crops with their respective controls.

Keywords: Soil, Vegetables, N, P^{32} tracer, K, Fertilizer, Seedling, Flowering, Harvesting

Introduction

Based on an analysis of the radio-logical data of 2000-2020 from nuclear power plants in India, BARC Mumbai have found the radioactive discharges from the NAPC and the result potential environment have been minimal. But a large number of nuclear atomic plant disposed off their waste in a natural water and soil due to which nutritional imbalance is created in both as well. Most of the units are taking appropriate measurement to prevent these contamination, but perhaps are not completely sufficient. Clay rich soil absorbs large quantities of water after rainfall becoming sticky and heavy, conversely it can also become very hard when dry resulting in shrinking and cracking of the ground. Fertilizers (NPK) are the essential macro nutrients for vegetable crops growth, nitrogen absorbs as NO_3^-/NH_4^+ , potassium- K^+ ion and phosphorus- $H_2PO_4^-/HPO_4^{2-}$ through their roots interception and presence of beneficial fungi. When NPK fertilizers are apply to the soil N, K absorbed easily but the difficulty with phosphatic fertilizers is that a large functions of it's fixed (75-80%) in the soil and only small portion (15-20%) is available to the plant. In the present manuscript study was to investigate the comparative and combine effect of phosphorus on utilization with different vegetable crops viz., cauliflower, brinjal and ladyfinger at various stage of growth parameters (viz., seedling, flowering, harvesting (fruit/vegetable) stages in a soil with their respective controls.

Experimental

The period of study for NAPC plant is from august 2023- december 2023 and pot culture experiment was conducted in the department of chemistry, Hindu College, Moradabad with the vegetable crops viz., cauliflower, brinjal and ladyfinger and four levels of phosphorus viz., 0.0, 0.5, 1.0, 1.50 gm $P_2O_5/35$ cm (pot), respectively. Soil sample were collected from experimental area and filled with 5.0 Kg soil capacity of 35cm radius of earthen pots. The soil contained 0.5% organic carbon and 3.0 gm/pot (35 cm), 10% and 5.125 gm/Pot (35 cm) available N, P and K_2O , respectively. The pH of soil was 7.2. A basal application of 20% N and 25% K_2O was applied at the time of sowing. Urea, single superphosphate and muriate of potash was used as the source of N, P, and K, respectively. Three vegetable crops viz.,

cauliflower, brinjal and ladyfinger were selected as a treatment crops. Four level of phosphorus viz., 0.0, 0.5, 1.0, 1.50 gm $P_2O_5/35$ cm (pot) were used as a tagged superphosphate having specific activity of 0.40 mCi/gm P_2O_5 which was produced from Narora Power Station (NAPS) a nuclear power plant located in Narora, Diba Tehsil Bulandshahar Distt. (U.P.) in India, coordinates 28°9' N 78°24'34" E, reactors-2, cooling source Narora Barrage river Ganga and power generation in 418 M.W. It is situated 103 Km. south of Moradabad Distt.

The sample were collected and measured for radius of 15 km of the NAPC Plant the concentration of the fission products beyond 5 km radius was below the minimum detectable activity of the instrument used. The radioactive

phosphorus ^[1] and total-P were determined ^[2, 3] in plant and P^{32} counting for soil was done under identical condition in GM Counter. All growth parameters of the vegetable crops viz., cauliflower, brinjal and ladyfinger were statistically analyzed ^[4].

Results and Discussion

Data presented in table-1 reveals that the total phosphorus uptake increased significantly with increasing level of phosphorus at all the stages of growth in vegetable crops with their respective controls also shown in the form of graphic in fig. A. This might be due to the higher availability of phosphorus with increasing phosphorus level ^[5, 6].

Table 1: Effect P level on total P-uptake (mg/pot) by vegetable crops at different stages of growth parameters.

P levels gm $P_2O_5/35$ cm	Seedling Stage			Flowering Stage			Harvesting Stage (fruit/vegetable)		
	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger
P _c	5.21	6.77	5.38	15.60	15.52	25.91	47.49	51.73	46.93
P _{0.05}	9.33	6.74	8.25	21.86	24.48	30.71	67.31	69.04	65.31
P _{1.00}	11.01	11.16	12.11	33.12	33.68	38.33	84.47	89.12	84.93
P _{1.50}	11.64	11.54	11.24	35.41	39.61	39.62	89.81	88.52	95.52
Mean ±SE	9.28±(0.12)	9.23±(0.01)	8.23±(0.1)	26.50±(0.18)	28.32±(0.12)	33.13±(0.03)	75.08±(0.21)	78.12±(0.15)	73.18±(0.34)
Effect	P		V	P		V	P		V
±SEm	0.30		0.31	0.28		0.16	0.41		0.17
F	342.042**		452.163**	1105.01***		1240.13***	798.53***		1415.52**
CD	0.35		NS	2.71		2.28	1.44		NS

**P<0.01,

***P<0.001a%level

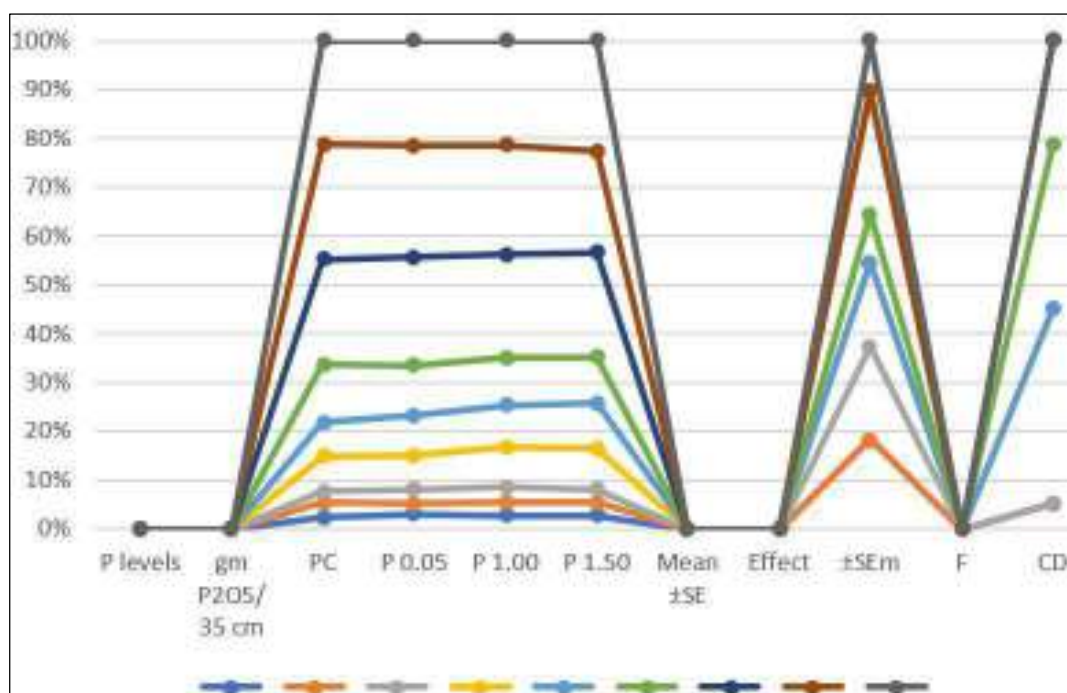


Fig A: Showing effect of P level on total P-uptake (mg/pot)

Table-2 & fig. B exhibit that % P derived from fertilizers increased significantly with increasing level of P in all growth parameters of all vegetable crops with their respective controls. This might be due to the fact that more

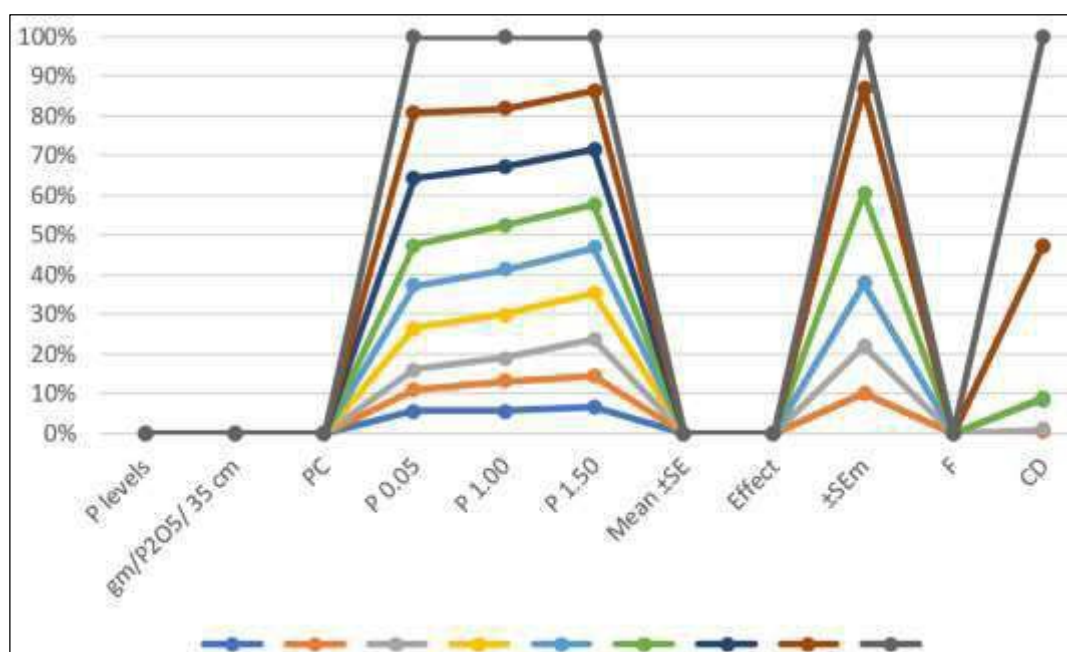
the phosphate fertilizer added to soil more the crop removal. On the other hand the P fixation capacity of soil being limited the pool of availability absorbed by the crops.

Table 2: Effect of P level on P derived from fertilizer (%) by vegetable crops at different stages of growth parameters

P levels gm/P ₂ O ₅ / 35 cm	Seedling Stage			Flowering Stage			Harvesting Stage (fruit/vegetable)		
	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger
P _C	-	-	-	-	-	-	-	-	-
P _{0.05}	20.80	19.00	18.39	38.17	38.37	37.73	60.85	59.58	69.45
P _{1.00}	22.16	28.39	23.35	42.76	43.57	43.11	58.50	56.42	70.77
P _{1.50}	28.59	33.78	41.51	50.34	49.41	48.01	61.17	64.70	59.41
Mean ±SE	17.89± (0.01)	20.54± (0.03)	21.02± (0.03)	32.82± (0.20)	32.84± (0.15)	32.22± (0.01)	45.13± (0.30)	45.17± (0.03)	49.63± (0.02)
Effect	P		V	P		V	P		V
±SEm	0.024		0.029	0.038		0.055	0.064		0.031
F	553.13**		713.12**	1354.27***		698.30***	325.05***		3653.20**
CD	0.02		0.02	0.32		0.02	1.63		2.23

**P<0.01,

***P<0.001 at 5% level

**Fig B:** Showing P level derived from P utilization (%)

It is evident from table-3 that the % utilization of P decreased significantly with increasing levels of P at all the stages of growth parameters in all varieties, which means that the utilization of added P was not in proportion to applied P level, also shown diagrammatically in fig. C. On

the other hand with lower dose the available amount of P was less than the need of the crops for its growths as a result of which the efficiency of utilization of applied fertilizer P is higher at low dose and low at higher dose [7, 8, 9]

Table 3: Effect of P level on P utilization (%) by vegetable crops at different stages of growth parameters

P levels gm/P ₂ O ₅ / 35 cm	Seedling Stage			Flowering Stage			Harvesting Stage (fruit/vegetable)		
	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger
P _C	-	-	-	-	-	-	-	-	-
P _{0.05}	2.49	2.15	2.07	10.20	11.44	11.76	27.42	27.18	29.65
P _{1.00}	1.59	2.19	1.48	8.78	9.29	8.28	25.59	25.48	25.64
P _{1.50}	1.33	1.45	1.36	7.29	7.86	7.24	25.14	24.56	22.98
Mean ±SE	2.01± (0.01)	1.48± (0.12)	1.21± (0.01)	6.51± (0.03)	7.11± (0.02)	6.87± (0.15)	19.48± (0.02)	19.21± (0.18)	19.29± (0.26)
Effect	P		V	P		V	P		V
±SEm	0.023		0.025	0.022		0.051	0.001		0.004
F	132.01**		188.08**	310.002***		214.01***	184.12***		1000.15**
CD	0.20		0.36	0.18		0.28	1.35		0.12

**P<0.01,

***P<0.001 at 5% level

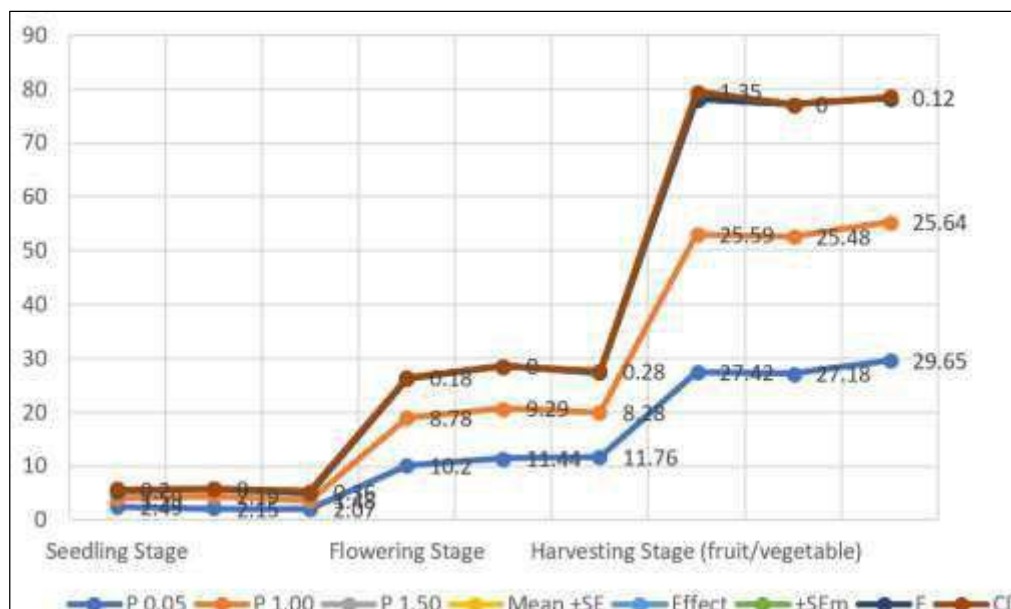


Fig C: Showing effect of P level on P utilization (%)

Data presented in table-4 reveals that as the dose of P increased, the uptake of P from soil sources also increased at all the growth stages. This might be due to the proportionately higher uptake of P with increased dry matter

yield of vegetable crops as well as better root system development caused by P application which enabled the plant to exploit the P from soil⁹ to a greater extent also shown in fig. D.

Table 4: Effect of P level on soil P-uptake (mg /pot) by vegetable crops at different stages of growth parameters

P levels gm/P ₂ O ₅ / 35 cm	Seedling Stage			Flowering Stage			Harvesting Stage(fruit/vegetable)		
	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger
P _C	7.23	8.79	6.90	17.62	17.54	19.84	49.51	52.75	49.95
P _{0.05}	8.12	7.73	8.37	14.67	16.19	17.05	53.70	55.92	49.75
P _{1.00}	9.88	9.22	9.09	19.21	19.23	17.78	58.63	63.69	58.77
P _{1.50}	10.04	9.70	9.69	18.43	20.78	20.87	65.32	66.22	65.39
Mean ±SE	8.80± (0.04)	8.86± (0.14)	8.29 ± (0.12)	17.48± (0.11)	18.68± (0.02)	18.88± (0.12)	56.54± (0.13)	59.89± (0.15)	45.00± (0.17)
Effect	P		V	P		V	P		V
±SEm	0.042		0.024	0.024		0.028	0.047		0.048
F	178.48**		198.451**	386.012***		178.05***	129.09***		310.37**
CD	0.07		0.45	0.14		0.43	0.14		0.42

**P<0.01,

***P<0.001 at 5% level

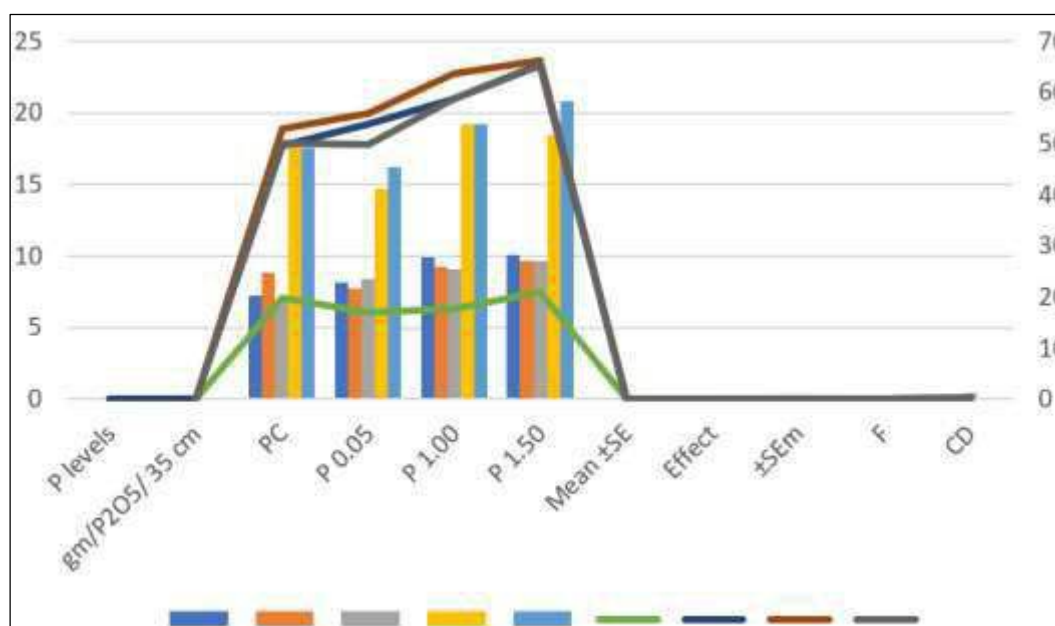


Fig D: Showing effect of P level on soil P-uptake (mg/pot)

Table-5 & fig. E reveal that the dry matter yield of vegetable crops increased at all the stages of growth parameter in vegetable crops with increasing level of P with their respective controls ^[9, 10]. This increasing yield was due to

the response of P over control indicating that the soil was not in a position to supply enough P as required by the vegetable crops and as soon as the P deficiency was made up, increased yield was obtained ^[11].

Table 5: Effect of P level on dry matter production of vegetable crops at different stages of growth parameters (gm/pot)

P levels gm/P ₂ O ₅ / 35 cm	Seedling Stage			Flowering Stage			Harvesting Stage (fruit/vegetable)		
	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger	cauliflower	brinjal	ladyfinger
P _C	4.57	5.37	4.81	9.10	8.57	9.41	15.87	20.53	19.53
P _{0.05}	4.25	5.57	5.14	10.80	11.31	12.22	24.59	23.28	23.26
P _{1.00}	6.71	6.39	5.60	12.70	13.10	12.84	26.15	27.51	26.33
P _{1.50}	6.77	6.51	6.15	12.59	13.69	13.37	28.88	28.78	23.04
Mean ±SE	5.58± (0.13)	5.96± (0.24)	5.43± (0.20)	11.10± (0.20)	11.68± (0.15)	11.96± (0.32)	23.87± (0.42)	25.02± (0.01)	23.04± (0.03)
Effect	P		V	P		V	P		V
±SEm	0.021		0.0054	0.016		0.0018	0.003		0.056
F	415.32**		721.005**	115.47**		347.23**	147.01**		347.12***
CD	0.14		0.02	0.46		0.23	0.02		0.16

**P<0.01,

***P<0.001 at 5% level

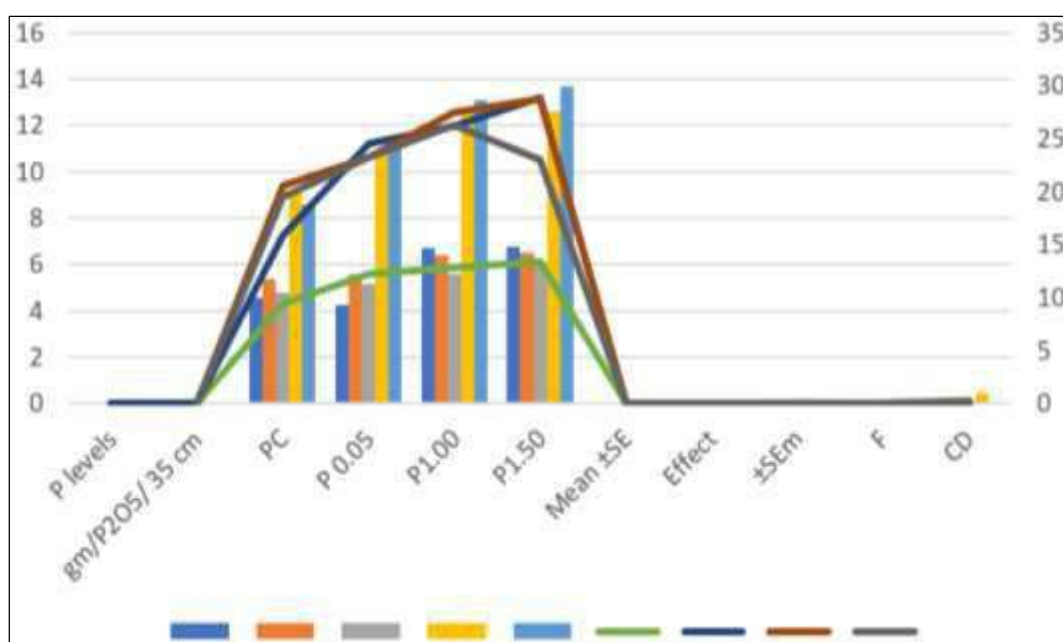


Fig E: Showing effect of P level on dry matter production.

Finally we have come to the conclusion that 0.40 mCi/gm this amount of radioactive phosphorus obtained from the analysis of plant waste materials does not have any deleterious effect on plants and ecological environment as well, while positive results are being obtained from the above fact that application of increasing doses of phosphorus fertilizer brings about increased uptake of P in all the vegetable crops, increased dry matter yield and increased uptake of P from soil sources. The phosphorus derived from fertilizer also increase but percentage utilization of applied P decrease indicating thereby that the efficiency of P utilization is more lower level of fertilization then at higher doses.

Conclusion

Above research findings conclude that amount of radiation P³² obtained from analysis of plant waste material which was 0.40 mCi/gm, does not have any deleterious effect on the vegetable crops growing in the P³² accumulated soil. There is a possibility of saving of Phosphorus fertilizer from above recommended doses. Moreover radioisotopes exposure can improve the quality and productivity for

agriculture products with insects, pesticides and disease management and drought resistance etc. and can be used as research tools to develop new agriculture strains.

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